FREDERICK W. TAYLOR

FATHER OF SCIENTIFIC MANAGEMENT

In concluding let me say that we are now but on the threshold of the coming era of true coöperation. The time is fast going by for the great personal or individual achievement of any one man standing alone and without the help of those around him. And the time is coming when all great things will be done by the coöperation of many men in which each man performs that function for which he is best suited, each man preserves his individuality and is supreme in his particular function, and each man at the same time loses none of his originality and proper personal initiative, and yet is controlled by and must work harmoniously with many other men.

Taylor, *On the Art of Cutting Metals*

The Chairman: Mr. Taylor, do you believe that any system of scientific management induced by a desire for greater profits would revolutionize the minds of the employers to such an extent that they would immediately, voluntarily and generally enforce the golden rule?

Mr. Taylor: If they had any sense, they would.

Hearings in 1912 *before Special Investigating Committee of House of Representatives*

Fred. W. Taylor

Frederick W. Taylor

FATHER OF SCIENTIFIC MANAGEMENT

BY
FRANK BARKLEY COPLEY

IN TWO VOLUMES
VOLUME I

HARPER AND BROTHERS, PUBLISHERS
NEW YORK AND LONDON
MCMXXIII

THE PLIMPTON PRESS · NORWOOD · MASSACHUSETTS
PRINTED IN THE UNITED STATES OF AMERICA

THE AUTHOR'S ACKNOWLEDGMENTS

IN 1911, when John Fritz, that most beloved of old-school engineers, was bringing out his autobiography, Taylor wrote to him apropos of this: "I think no book is more stimulating than the history of a devoted and successful life." It was thoroughly characteristic of Taylor, however, that he refused even to take steps to facilitate the preparation of a biography of himself after he was gone. On at least two occasions it was suggested to him, but his only response was a grimace.

For various reasons, not the least of which was the complex nature of Taylor's work, the preparation of his biography has offered difficulties such as the writer could not have coped with unaided; and it needs to be strongly brought out that, besides having had the advantages of access to Mr. Taylor's correspondence and papers and the full coöperation of Mr. Taylor's relatives, friends, and professional associates in general, the writer all along has had the support and counsel of a Committee consisting of Mrs. Taylor and Messrs. Sanford E. Thompson, Morris L. Cooke, and Edward W. Clark, 3rd, with Dr. Harlow S. Person, managing director of the Taylor Society, serving as a sort of informal but none the less important and exceedingly helpful member. The writer, in fact, is indebted to Dr. Person for far more in the way of valuable suggestions than can here be well stated.

To mention all the others from whom the writer has received courtesies in the course of this work, would be to draw up a list containing scores of names; and while the necessity of thanking them in blanket form is to be regretted, it is hoped they will realize that the thanks are very sincere and hearty.

Special mention must surely be made of the three engineers who, with Mr. Cooke and Mr. Thompson, formed the group that was so intimately associated with Mr. Taylor. Though the untimely death of Mr. Henry L. Gantt occurred while the preparation of this biography was in progress, the writer had the benefit of several talks with him. Being in a position to make a large contribution, Mr. Horace K. Hathaway met with unfailing courtesy the demands upon his time which this involved. Then there is Mr. Carl G. Barth; let it not be thought that because he is mentioned last, his contribution was among the least. Upon his store of fact and philosophy the writer drew almost continually throughout the work, and this especially in connection with the more technical parts.

It is to be feared that the foregoing statement of the writer's indebtedness to others in general is wholly inadequate. At the same time, it is to be recognized that for all statements in this work, as well as the general manner of their presentation, the writer is solely responsible.

CONTENTS

VOLUME ONE

ILLUSTRATIONS

VOLUME ONE

A FOREWORD BY THE AUTHOR

Among the names of those who have led the great advance of the industrial arts during the past thirty years, that of Frederick Winslow Taylor will hold an increasingly high place. Others have led in electrical development, in the steel industry, in industrial chemistry, in railroad equipment, in the textile arts, and in many other fields, but he has been the creator of a *new science*, which underlies and will benefit all of these others by greatly increasing their efficiency and augmenting their productivity. In addition, he has literally forged a *new tool* for the metal trades, which has doubled, or even trebled, the productive capacity of nearly all metal-cutting machines. Either achievement would entitle him to high rank among the notable men of his day; — the two combined give him an assured place among the world's leaders in the industrial arts. . . . Others without number have been organizers of industry and commerce, each working out, with greater or less success, the solution of his own problems, but none perceiving that many of these problems involved common factors and thus implied the opportunity and the need of an organized science. Mr. Taylor was the first to grasp this fact and to perceive that in this field, as in the physical sciences, the Baconian system could be applied, that a practical science could be created by following the three principles of that system, viz.: the correct and complete observation of *facts*, the intelligent and unbiased *analysis* of such facts, and the formulating of laws by *deduction* from the results so reached. Not only did he comprehend this fundamental conception and apply it; he also grasped the significance and possibilities of the problem so fully that his codification of the fundamental principles of the system he founded is practically complete and will be a lasting monument to its founder.

Henry R. Towne,
Chairman of the Board of the Yale & Towne Manufacturing Company, and past president of the American Society of Mechanical Engineers

A FOREWORD BY THE AUTHOR

Largely in the Nature of a Review of the Facts which Make the Subject of this Biography a World Figure.

IN the latter part of the eighteenth century, the steam engine, by furnishing the power previously lacking, stimulated the development of mightier and mightier machine-tools, and so precipitated a revolutionary change in our Western civilization.

In that part of the nineteenth century represented by the 1880's, this development of machine-tools reached a point marking the real beginning of large-scale production as we know it to-day.

Since this our modern or large-scale form of industry began, the man who has influenced it *most fundamentally* is Frederick Winslow Taylor, who was born in Philadelphia in 1856, and who died in that city in 1915. Underlying and shaping for good or ill all the features of industry is management; and Taylor was the inaugurator and father of, as well as chief worker in, the movement to impart excellence to management by viewing it as an art based on scientific principles. Universal in scope, his work long since has penetrated to every country where modern industry is established, and it is probable that in these countries there is no person who has not in some degree been affected by it, however unconsciously.

With him the thing of major importance was his general principles. Of these the first and greatest was that of determining all questions on a basis of fact as revealed by an expert and thorough investigation; and his work in the metal-cutting field, which was forced on him in consequence of his purpose to place machine-shop management on a scientific basis, remains the classic example of what such investigations can mean to industry and, through industry, to us all. Says Henry R. Towne:

> Under the magic influence of Frederick W. Taylor's genius, the art of cutting metals, which underlies all the metal industries, made a greater advance than during the previous ages since the days of Tubal Cain. In no other field of research that I can recall has investigation, starting from so low a point, attained so high a level as the result of a single continued effort.

That Taylor in all his investigating was not only scientifically thorough but exceptionally so, will appear from the comment on his paper of 1906 *On the Art of Cutting Metals* made by that distinguished Frenchman, Henri Le Chatelier, member of the Academy, professor of chemistry in the Sorbonne, recipient of the Bessemer medal, father of exact high-temperature measurements, and director of *Revue de Metallurgie*, the leading organ of the French iron and steel industry:

> The near future will show us the service which has been rendered to the mechanical arts by this generous publication of researches pursued with such uncommon perseverance.
>
> But even now we can admire without reserve the scientific method which has controlled this whole work. It is an example unique in the history of the mechanic arts. We have all admired the researches of Sir Lothian Bell, on blast furnaces, and those of Sir William Siemens on the regenerative furnace; but notwithstanding the high scientific value of the work of these two great engineers, on reading their papers neither of them leaves an impression on the mind which can be compared with that of Mr. Taylor's paper. It is a model which every young engineer will have to study.
>
> We believers in the scientific study of the arts have all been teaching our students that in investigating practical problems it is necessary, first, to accurately determine and define the various factors which

enter into the problem; then to classify these factors according to the degree of their importance, and lastly, to study the effect of each of these factors as variables independently. But when we see how little respect is shown to these principles even in the laboratories of pure science; when we see the sovereign contempt with which they are treated by every technical man, we come sometimes to doubt our own teaching, and to ask ourselves whether after all we are not teaching our young men wrong methods.

And yet, the systematic application of these very methods — nobody can deny it any longer — has been preparing during all these years to transform machine shop practice from the domain of rule of thumb to that of exact science. The scientific method is now about to receive the crown which it deserves, thanks to the generous publication of the President [as Taylor then was] of the American Society of Mechanical Engineers.

One of the dramatic incidents of Taylor's metal-cutting investigation was the discovery of high-speed tool steel; and what all who are familiar with the subject know is that this discovery has made it possible to increase machine-shop cutting feeds and speeds, and thereby production, from two to four or more times. One engineer has referred to it as a discovery "which is, at a very conservative estimate, worth fifty million dollars per year to the machine industry of this country."[1] We also read that "by means of these high-speed tools the United States during the World War was able to turn out five times the munitions that it otherwise could have done in the same time. On the other hand, if Germany alone had possessed the secret of the modern steels no power could have withstood her."[2]

It has been well said that the really great thing about all of Taylor's investigations was not the information they yielded

[1] Forrest E. Cardullo, *Industrial Administration and Scientific Management;* reprinted from *Machinery* in *Scientific Management*, Clarence Bertrand Thompson, p. 62.

[2] Edwin E. Slosson, *Creative Chemistry*, p. 280.

by itself considered, but the demonstration they gave of the economic gain to be derived from management's waking up to its own functions and establishing standard practice based on the scientific method. Hardly would it be possible, we believe, to exaggerate the influence Taylor has had in the general way of arousing industrial management. But while all things indicate that his place in history is broadly to rest on the demonstration his work afforded of the applicability of the scientific method to management, it would be an egregious error to consider that his permanent contribution is limited to this broad service.

While he recognized that principles are of major importance because in them is the philosophy, the spirit, the life, he also recognized that it is system which gives *body* to principles, that enables them to *work.* And being as intensely practical as he was scientific, he, even while his principles still were actuating him more or less as "propulsions from the unconscious," worked out definite methods and mechanisms for their embodiment, and at length so coördinated these methods and mechanisms as to form of them a coherent and logical, if highly flexible, system.

The grand ends to which this system is all directed may here be defined as (1) the determination of best or standard ways, implements, and materials by scientific investigation and experimentation, and (2) a control so extensive and intensive as to provide for the maintenance of all standards in this way reached.

By others (its father himself objected to its being branded with his name) this system is commonly called the Taylor System of Scientific Management, or, more briefly, the Taylor System.

Though the comprehensive programme it represents is still far from being understood in its entirety, it is the fact that the principles, methods, and mechanisms bound up in it have to-day become, in all enlightened quarters, the standard by which the merit of management is judged.

A conspicuous example of this is afforded by the course of the Committee on Elimination of Waste in Industry, appointed in 1921 by Herbert Hoover in his capacity as president of the Federated American Engineering Societies. Confronted by the need of a "standard method of investigation," the Committee "prepared an analysis of those factors and operations in industry in which waste might be expected to be discovered, provided a comparison was made between average practice and the best known practice," and even a casual glance at the "Guide Questions for Field Workers" which were the outcome of this analysis shows that the Committee accepted Taylor's leading principles, methods, and mechanisms as constituting the "best known practice," at least as regards things designed to remedy "low production caused by faulty management of materials, plant, equipment, and men."[1] As the majority of the committee of seventeen engineers named by Mr. Hoover were either Taylor's direct disciples or old-time close students of his work, this is what might have been expected; but it is significant that the Committee should, in the first place, have been made up in this way.

Another significant thing is that when industrial engineers and plant executives who sincerely believe they are opposed to "Taylorism" come to present the details of their work in management, they show that, in the measure that they are progressive, they have drawn directly, if unconsciously, upon Taylor philosophy and technic — a fact which seemingly may be largely explained by their being readers of the technical

[1] Besides this "aspect of waste in industry," the Committee investigated "interrupted production caused by idle men, idle materials, idle plants, idle equipment"; "restricted production intentionally caused by owners, management or labor," and "lost production caused by ill health, physical defects and industrial accidents." See *Waste in Industry*, McGraw-Hill Book Company, New York.

press, in which for years the main devices of management described and advocated have been those of Taylor, even while they seldom have been presented as such.

Frequently Taylor's name has been suppressed in connection with his originations and developments because of the acrimonious controversy aroused in his latter years by certain features of his work. Again, he himself had little or no interest in claiming originality in anything; with him the important question always was, not who originated the thing, but what was the thing worth; and from 1901, when he decided that he "no longer could afford to work for money," until his death fourteen years later, he gave lavishly of his experience and thinking, not only in the broad way represented by his papers and platform addresses, but also in the highly detailed way represented by his consultations with the hundreds of persons who sought him out at his home and were conducted by him through the neighboring plants where his system was to be seen in actual operation.

All in all, it is not strange that, while many of his contributions to the pure technic of management have now entered into the very warp and woof of modern management properly so called, they usually have gone unrecognized as his handiwork.

A very interesting fact in this connection is that, while developing his general system, he was forced to become a pioneer in the development of modern industrial accounting, taking up this study in the early 1890's when the general practice of accounting in industry was of the crudest, and working out a technic which, as regards some of its features, chiefly those relating to the highly important matter of costs, is only beginning to be appreciated by professional accountants as a group and by the industrial world as a whole. Yet the mere fact that Taylor added to his other achievements those of an expert accountant will astonish many persons well acquainted with his general engineering work.

In person he was unable to extend his system beyond the shop. It was not that his vision was here limited, but that the specific things involved in his systemization of the shop, as notably in the case of his metal-cutting investigation, made it a task so heroic that, after accomplishing it, he hardly could have done much else than call attention to it and leave it to others to extend the principle of the thing. Since his death great strides have been made in extending his grand objects of fact determination and of control to departments other than manufacturing or fabricating, notably selling, *and to the enterprise as a whole.* And this, we believe, is rightly called the most significant development in industry to-day on the score of the pure technic of management.

Of course there is much more to management than its strictly technical or engineering side. There is the human side, or that which has to do with the selection, placement, training, and general spirit pertaining to the treatment of employees — in fine, with all those factors of organization which now are summed up in the *personnel* movement, the promise of which hardly can be overestimated, seeing that it is the outcome, not merely of a growing recognition of the fact that the payment of even the best wages cannot by itself bring the best out of men, but of a suspicion, which seems to be making its way up to the level of the fully conscious, that righteous human relations may not be inconsistent with the practical, and that the ethical may not be incompatible with the economic. Here again Taylor was a bold originator and pioneer worker; perceiving nearly forty years ago, or in the middle 1880's, that men, too, should be studied, he established the "hiring and firing" of employees as a separate function of management and confided it to an official who was the direct forerunner of the ultra-modern personnel manager.

The truth is that the human side was to Taylor the one of far superior importance. We shall see, in fact, that *all his* *work in developing a system of scientific management was the direct outcome of his purpose to find a remedy for the labor problem that grew up coincidentally with and in consequence of the development of large-scale production.* And as he addressed himself to this problem in the 1880's when large-scale production was beginning, it may be said that this problem hardly had appeared when his work on its solution was begun.

That his general message was indeed one of universal import, is indicated by the promptness and extensiveness with which his papers, *Shop Management* (1903), *On the Art of Cutting Metals* (1906), and *The Principles of Scientific Management* (1911) were translated into other languages. In the case of his last paper we find that, within two years of its book publication by Harper & Brothers, it had been translated into French, German, Dutch, Swedish, Russian, Lettish, Italian, Spanish, and Japanese. In each case the translation was undertaken on his own initiative by some native or resident of the country where the language concerned was spoken. And after its author's death there came to this country a copy of *The Principles* translated into Chinese by a Chinese.

Curious in many of its aspects is the way individuals and governments in other lands have turned to the work of this man who was an American in the sense that his ancestors on both his father's side and his mother's were born on American soil since the earliest colonial days.

Hardly, for example, could there be imagined two more dissimilar governments than that of the French Republic and that of Soviet Russia, as these existed in 1918 and later. As regards most particulars of political and economic theory and ideal, they represented antipodes of thought. Yet in the early part of 1918, when the World War still was carrying on its perfect work of destruction and woe, these governments became conscious of a common need, and to meet it each took up the Taylor System.

The French Republic called this need that of "realizing the maximum of economy in labor." Soviet Russia called it that of bringing about "the highest productivity of labor."

Previous to 1918, the French Ministry of War had taken steps toward the adoption in the plants under its control of various features of the Taylor System. In a circular dated February 26, 1918, and signed by Georges Clemenceau, the Ministry pointed out that there was "an imperative necessity that all the Heads of Military Establishments should turn to the study and application of methods of work suitable to the exigencies of the moment," and it went on to direct attention to that basic principle of "Taylorism" which it described as "the employment in every kind of work of the minimum of labor through scientific research into the most advantageous methods of procedure in each particular case." With this end in view, the Ministry ordered that "in every plant or, at least, in each type of plant" there be created a Planning Department, this being the central feature of the mechanism of the Taylor System. And the Ministry recommended that the "Heads of Plants and their Planning Departments" should consult various works in which the Taylor System was described.[1]

Unlike the French Government, whose control of manufacturing plants was limited to those of the military establishment, the Russian Soviet Government had, in the name of the proletariat, assumed the control as well as "expropriated" the ownership of all the plants within its political jurisdiction. In its issue of April 28, 1918, *Pravda,* the official Soviet organ, published a long article by N. Lenin on "The Urgent Prob-

[1] These were specified as follows: 1. *Principles of Scientific Management,* F. W. Taylor; 2. *Scientific Organization,* extract from *Revue de Metallurgie,* Vol. 12, April, 1915, Dunod and Piat, publishers; 3. *Taylorism,* by Victor Cambon, Nancienne Press, Nancy; 4. *The Taylor System,* Extract from *Bulletin des Amis de l'Ecole Polytechnique,* Henri Le Chatelier, Dunod and Piat, publishers.

lems of the Soviet Rule," and under the heading, "Higher Productivity of Labor," Lenin wrote:

> We should immediately introduce piece work and try it out in practice. We should try out every scientific and progressive suggestion of the Taylor System. . . . The Russian is a poor worker in comparison with the advanced nations, and this could not be otherwise under the régime of the Czar and other remnants of feudalism. To learn how to work — this problem the Soviet authority should present to the people in all its comprehensiveness. The last word of capitalism in this respect, the Taylor System, as well as all progressive measures of capitalism, combined the refined cruelty of bourgeois exploitation and a number of most valuable scientific attainments in the analysis of mechanical motions during work, in dismissing superfluous and useless motions, in determining the most correct methods of work, the best systems of accounting and control, etc. The Soviet Republic must adopt valuable and scientific technical advance in this field. The possibility of socialism will be determined by our success in combining the Soviet rule and the Soviet organization of management with the latest progressive measures of capitalism. We must introduce in Russia the study and teaching of the new Taylor System and its systematic trial and adaptation.

Incidentally it may be asked how it was in World War times with the government of Taylor's own country. In the winter of 1914–15, the Congress of these United States of America attached to all appropriation bills riders especially designed to cripple the Taylor System in the government establishments that already had adopted it — that is, the manufacturing arsenals — and to prevent its adoption, at least as far as its direct application to labor was concerned, in other government establishments.

This looks like a clear case of a prophet's not being without honor from governments save in his own country; and it is the fact that while every American Congress since 1914 has continued to legislate against the Taylor System in the way we have just mentioned, the persons who steadily come here from Western Europe to study this system continue to include many government officials.[1]

It also is the fact that Taylor's work is far more *widely*, if not better, known abroad than here, this being especially true of France. In September, 1917, when sending a dispatch from Paris to *The Evening Post* of New York about the arrival of the first American troops in France, Norman Hapgood said: "One finds 'Taylorism,' rather freely interpreted, brought up in connection with the efficiency shown at the American camp. Taylorism, indeed, has become more a French word than an American word. Essayists on public affairs are addicted to it." A conspicuous example of the French interest in "Taylorism" is the Foundation Michelin, which, endowed by Edouvard Michelin, president of Michelin & Cie, seeks to promote the investigation of Scientific Management and the Taylor System by courses in the higher technical colleges of France, by courses of public lectures, and by sending young engineers to the United States to study management methods. In Vienna, again, we now find a periodical entitled *Taylor-Zeitschrift.*

However, outside of comparatively small circles principally made up of technical men, misapprehension of Taylor's work has everywhere been more common than apprehension. In the minds of the general public here and abroad it is likely to be viewed simply as some new kind of a wage system, or all too frequently vulgarized by being associated with loose, crude, and sordid notions of what constitutes efficiency. Even in technical circles it is common for men who appreciate some features of Taylor's work to fail to understand other features. Any

[1] The study given to Taylor's work by foreigners and its teaching at Harvard, Dartmouth, and the University of Pennsylvania as mentioned a little later in the text, may be taken as pointing to the very interesting fact that Taylor is the only man who ever has worked out a *definite* philosophy of management and a logical, coherent system of general applicability.

comprehension of his work, or grasp of it as a whole, is rare; this being exemplified by the way various of his mechanisms are adopted without any conception of the part they play in his general scheme.

Under all the circumstances, this failure to comprehend is just what might be expected.

Though management engineering long since has been officially recognized by the American Society of Mechanical Engineers, the science of management is one that still is struggling for general recognition. When Taylor began in the early 1880's, it was not generally recognized, at least in this country, that there could be even such a science as that of mechanical engineering. Empiricism and rule of thumb were here the general things; and the fact is that no more in Europe than here had any real attempt been made to base the art of management on scientific principles, or view management as "seeking, coördinating, arranging, and systematizing knowledge, and by observation, comparison, abstraction, and generalization deducing laws." Hence Taylor began with neither a shred of theory nor vestige of technic to guide him. These he had to establish, modify, and develop under the influence of accumulating experience in the course of his practical work as manager and engineer.

Dealing with a new science, he naturally found the difficulties of teaching it immense; and while his general system of management several years before his death received specific academic recognition at Harvard, Dartmouth, and the University of Pennsylvania, and continues to be taught in the business schools of those institutions, it still remains true that he who would follow Taylor in the practice of this science must depend far more on his capacity to develop on his own account than upon any guidance he can receive from history and theory.

As a matter of fact, Taylor died without leaving behind him any adequate statement of his life work. Loving to do things, he hated to write about them. The papers in which he forced himself to attempt the exposition of his principles and methods, while able as far as they went, never encompassed his thinking and his achievement. Under the lash of his imperious will, he mastered an exceptionally lucid, concise, and vigorous style, but his power of expression remained decidedly limited. Dealing from his earliest youth with general principles and laws, and living more and more in their vision, he never acquired skill in their formulation. He was born a seer, but was not a born sayer. His temperament, one of extraordinary intensity, served him admirably in his capacity as executive; it gave him extraordinary power to arouse and inspire others; at the same time, it stood in the way of his attaining excellence as an expositor of his own thinking; he was likely to state things in a temperamental way, and thus leave impressions that did both himself and his work injustice. He has been called the *beau ideal* of a scientific investigator; no form of charlatanism could find any lodgment in him; yet along with his intensely scientific bent went not only great practicality, but also great amiability and sociability, and this, together with a marked instinct for the dramatic, inclined him to over-popularize his expositions, or over-adapt them to his immediate audience and the passing scene.

True, he often was not without large success in explaining various details of his work, as notably in his monumental treatise *On the Art of Cutting Metals* and when he lectured at Harvard. Even so, the fact remains that he died without having attempted any systematic statement of his work as a whole.

Now, of course, a biography is the history, not of a science or of a movement, but of " the life of a particular person "; and it may be said that Taylor's life should prove an inspiration to everyone, even those who think they have (and in this they surely are mistaken) no interest in industry and its tremendous problems. Certainly in beginning this work the writer found ready for such skill in depiction as might be his a unique personality, a wholly unprecedented human being, a remarkably lovable, if easily misunderstood, character, and a wonderfully romantic career. There, indeed, was a world figure. The world, as you viewed it in the large, did not know it. But the world would.

At the same time, the writer was confronted by the fact that perhaps nine-tenths of Taylor's activities were, from his early youth, devoted to the single object of developing and propagating his system of Scientific Management. And this, as we have seen, was no case of a scientist whose science was well known. Quite on the contrary. Furthermore, the writer had to consider that, in building up that which was his life work, Taylor exemplified a marvelous attention to detail. In fact, it was peculiarly his genius that he saw the importance of details which were commonly — aye, universally — overlooked or neglected. Hence the story of Taylor, to be true, not only had to reflect his concentration on a single object, while so interpreting this object as to meet the prevailing lack of comprehension in this connection, but also to reflect his attention to detail.

As it was the writer's task to present a history of Taylor's life, in distinction to his life work, he has not, to be sure, felt called upon to deal exhaustively, or even extensively, with those details of Taylor's life work which are purely technical. In point of fact, the story of the development of the details of Scientific Management is sometimes more the story of one of Taylor's associates than of Taylor himself; he from the beginning having shown the true executive instinct in employing others, preferably those with forms of ability supplementing his own, to *put through* the details and thus leave his own mind free for the general direction. On the whole, the writer has concerned himself mainly with Taylor's principles and philosophy. Yet he necessarily had to deal with many of the larger details to illustrate the principles, and with many of the smaller ones to indicate Taylor's grasp of them.

Another thing here to be brought out is that, to take a correct and just view of Taylor's life, was to recognize that the stress must all be placed on his thinking. True, his life was not spent in laboratory or study. He lived amidst the carrying out and the carrying on of things. And he had in more particulars than one the true executive instinct. Like Napoleon's, his action was as prompt as his thought. When he had thought a thing out, it was the signal for him to engage in a struggle, no matter against what odds, to bring the thing to pass in the every-day, workaday world. He jubilated in his *will to get there*. And surely his adventures were none the less stirring for being encountered, not among "antres vast, and deserts idle, rough quarries, rocks and hills whose heads touch heaven," but among the fiery furnaces, the throbbing engines, and the ponderous, grinding machinery in the mighty workshops of modern Vulcan. Here, too, can a man's story be one of "battles, sieges, fortunes . . . of most disastrous chances, of moving accidents." He struggled valiantly, and considering the opposition he needs must encounter, his achievement was great. Nevertheless, what he achieved was not so important or so significant as what he failed to achieve. It has been said that a man's reach should exceed his grasp, else what's a heaven for? That Taylor reached straight out for an industrial heaven must be conceded as you are willing to concede that the first law of heaven is *order*. And that surely was the important thing — the thinking that inspired this reaching out, that went to make up this ideal.

Do not we here have the language of enthusiasm, and do not the latest fashions in biographies all tend toward Detachment? It would be idle for the writer to pretend that he was anything but very warmly attached both to the person of Frederick W.

Taylor and to his work. But, while putting the reader on his guard against this, he may point out that perhaps, after all, there is something in the old, old principle that only through sympathy comes insight, and only through love, understanding. It is certain that — consciously, at all events — the writer has had in mind only the single aim of presenting the facts, saying the true word, making the just estimate, and offering the correct interpretation.

In closing it is submitted that, as they, too, come to learn the facts about Taylor and his work, those readers who have the imagination to see and the heart to feel must have their pulses quickened also. Hint of the reason of this already has been given in what has been said of the hundreds of persons interested in management who journeyed to Taylor's home — the home in Chestnut Hill, Philadelphia, which he called Boxly. In the past pilgrimages had been made to shrines formed by the homes of great thinkers, great seers, great teachers; men of elemental force, of great vital power. Such pilgrimages as those to Goethe at Weimar, and to Tolstoi at Yasnaya Polynana. These men were of the kingdom of literature. Now, for the first time, pilgrimages were made to the home of a man who was of the kingdom of industry. Yet was the object of the pilgrims the same; namely, to absorb wisdom and perhaps even more to be warmed, heartened, and inspired by the elemental force, the great vital power. And is it extravagant to say that here appears the prophecy of a new industrial order?

Consider what was, and is, at the basis of all Taylor's work. It all began, as every form of science has begun, not in observation alone, but in observation governed by *deliberation.* It is for want of deliberate thought that all of our industrial ills and labor problems have come upon us. "To make *anything* the object of thought," says Ralph Waldo Emerson, "is to raise it."

PROLOGUE

War, which was once essential and necessary for cultural progress, has lost this significance and has become the most dangerous enemy of civilization. Wars no longer measure stages of progress; inventions now perform that function. The decisive battles of mankind for freedom and power are fought today on the labor front. . . .

Socialism mistakes Europe's problem when it imagines that our fundamental evil is unjust distribution instead of inadequate production. . . . The truth is that only a trifling fraction of the product of European labor goes to provide the luxuries of capitalists. The greater part of that product is employed in converting a sterile continent into a fertile continent, a cold climate into a warm climate, and in maintaining under these artificial conditions a vast population that the natural resources of Europe could not feed.

Winter and overpopulation are sterner and more cruel despots than all the cruel capitalists in the world. Politicians and labor leaders are not Europe's true leaders in combating these evils. The true champions of the masses in this revolution are our engineers and inventors. . . .

The ultimate end of technical progress is to provide every man with the comforts and conveniences that are to-day reserved for millionaires. Therefore the inventor and the engineers are fighting want and poverty; they are not fighting wealth. They are fighting slavery; they are not fighting rulers. Their object is to universalize wealth, power, leisure, beauty, happiness. Their ideal is not to make all mankind a proletariat, but to make it an aristocracy. . . .

Ethics and technics are sisters. Ethics rules the natural forces within us. Technics rules the natural forces without us. Both seek to subjugate nature by spirit. . . .

Neither ethics nor technics alone can redeem the man of the North; for half-starved, half-frozen men can be neither fed nor warmed by ethics; nor can evil and avaricious men be protected from each other or made contented by technics. . . . It is in our continent that ethics and technics most completely supplement each other.

Apologie der Technik, Richard Nikolaus Coudenhove-Kalergi; *translations from advance articles in The Living Age, December* 2, 1922, *and January* 20, 1923

PROLOGUE

I

IT had been planned to have him follow his father's profession of the law, and at sixteen he was sent to Phillips Exeter Academy, to prepare for Harvard University. A year and a half later, he passed the Harvard examinations "with honors"; but hard study at night had so affected his eyes that they required a long rest from reading, and this seeming misfortune must assume for us the aspect of an intervention by that Potter in whose hands men's destinies are clay.

To find some outlet for his restless energy, he went to work in a small machine shop in Philadelphia, and though his eyesight presently was restored, he spent four years in this shop picking up the trades of the patternmaker and the machinist. "Throughout my apprenticeship," he wrote in his later years, "I had my eye on the bad industrial conditions which prevailed at the time, and gave a good deal of time and thought to some possible remedy for them." Already he had heard the call to that which was to prove his life work.

"It was this," he added, "that led me to go to a very much larger company, the Midvale Steel Works, in 1878." The times then being dull, he had to begin with the rating of a laborer and work at odd jobs on the floor of the machine shop. Then, against his wishes, he was made time clerk. Presently he got a chance to serve as a journeyman lathe hand. About two months later, when he was not yet quite twenty-three, he was made gang boss over the lathe hands, and soon after that was promoted to be foreman of the machine shop.

No sooner did he start at Midvale than what he regarded as the worst feature of the "bad industrial conditions" then generally prevailing was brought vividly home to him. The management thought it was running the shop, but it really was being run by the men in the sense that they had the work all carefully laid out. When a new man was taken on, he was talked to by the old hands something like this: "Here, you, don't do any more than three pieces this morning. At noon we will let you in on the game." As the young man who had been so strangely led into industry figured it, the shop was turning out only about a third of the work of which it was capable, even under the then existing conditions.

Now, no one knew better than he the reason for this "systematic soldiering." And as long as he remained with the rank and file he played the game with them. But when he became gang boss and foreman, then it was different. He was now on the "management's side of the fence"; and as he viewed it, what he primarily was there for was to *get output.* So, while he continued to sympathize with his men in their soldiering, he blithely started right in to break it up.

That he undertook to force a lot of mechanics of British, Irish, German, and Scandinavian origin to do what they honestly believed was against their interests, he could explain in his later years only by his inexperience. And the casual observer would not have found that he looked the part. He was of average height, and did not weigh more than 140. His build, to be sure, was of the close-knit, cordy, athletic type. But his blond hair was accompanied by mild, if frequently sparkling and mischievous, blue eyes, and his chin was not pugnacious. His expression, indeed, was commonly urbane, and there often appeared on his face a look of almost feminine sweetness. The Fates, however, had bestowed on this gently-born young man a superabundance of two qualities before which all opposition has a habit of melting in time: to the courage generally credited to the lion he added the bull dog's amply-demonstrated ability to "hold on tight with the teeth."

It was in these latter words that he himself described his superb endowment of the will persistent — and it was the only quality for which he ever publicly gave himself credit.

His good friends among the most intelligent workmen understood him very well, and they continued to be his friends — outside the works. There were some pretty rough diamonds in that shop, however; the young foreman frequently was threatened with violence, and the fight increased in bitterness; the men resorting to such things as the deliberate breaking of machines, and their foreman to large-scale fining and firing.

After about three years of this, the men gave in and promised to do a "fair day's work." They did, in fact, increase their production, but it was a victory that gave the young foreman no satisfaction. And this not merely because he was far from being convinced that the fair day's work represented by the increased production was a full day's work. Like all intense persons, "Fred" Taylor was likely, when he got talking, to resort to hyperbole; but surely he was not laying on the color too thick when on the witness stand in his later years he used these words in closing a description of his long struggle with his men at Midvale:

> I was a young man in years, but I give you my word I was a great deal older than I am now, what with the worry, meanness and contemptibleness of the whole damn thing. It is a horrid life for any man to live, not to be able to look any workman in the face all day long without seeing hostility there, and feeling that every man around you is your virtual enemy. These men were a nice lot of fellows, and many of them were my friends outside the works. This life was a miserable one, and I made up my mind to either get out of the business entirely and go into some other line of work, or to find some remedy for this unbearable condition.[1]

[1] Testimony given in 1912 before "Special Committee of the House of Representatives to investigate the Taylor and other systems of Shop Management."

He did not get out of the business; and in the decade 1880–1890, during which he remained at Midvale, he worked out the essentials of his remedy in principle, though he was destined to spend another decade and more in patient, extraordinarily thorough investigation and experiment such as was needed for modification, adaptation, development, rounding out, and coördination. In 1906, when he was fifty, he gained such distinctions as the presidency of the American Society of Mechanical Engineers and the honorary degree of Sc. D. conferred by the University of Pennsylvania; but it was only in technical and certain other limited circles here and abroad that, up to 1910, anything was known of him or of the great movement he had started. Then in this his fifty-fourth year he and his work were introduced to the general public through a sensational episode.

II

Early in the summer of 1910, the railroads of the northeastern section of the United States filed with the Interstate Commerce Commission new freight tariffs calling for a general advance in rates, and in September, October, and November the Commission held hearings to determine their reasonableness.

It was the first case of the kind. Not only were great sums of money involved, but the decision to be made would be likely to establish an important precedent. Represented by from fifteen to twenty lawyers, the shippers who would be affected by the proposed advances vigorously fought them. From the beginning the contest provided good "copy" for the newspapers, and it waxed in intensity.

The railroads, represented by nearly half a hundred attorneys, pleaded that they must have more money because of an increase in their operating costs, due mainly to an increase in wages of from five to eight per cent that their men had obtained the previous spring. Here was the old story: for all wage increases the public eventually must pay.

The shippers responded by boldly attacking the railroads on the score of their managerial efficiency, a thing in connection with which they all along had prided themselves they were particularly strong. It was argued that through more efficient management the railroads could save more money than they demanded in increased rates.

Chiefly instrumental in launching this attack was Louis D. Brandeis, destined to be elevated a few years later to the bench of the United States Supreme Court. A forward-looking lawyer of unusual public spirit, he attended the hearings as the unpaid counsel for the Trade Associations of the Atlantic Seaboard, and by reason of his keen intellect and force of character became the leader among the lawyers assembled in opposition to the railroads.

In November, when the hearings had been proceeding for about two months, Brandeis suddenly introduced a group of eleven witnesses composed of engineers and of managers of industrial plants, one after another of whom, in fashion highly dramatic, testified to the same singular effect. This was that there was a definite way by which the railroads could increase wages and at the same reduce their costs. The way was that of Scientific Management. One of the witnesses, Harrington Emerson, an engineer, testified that in this way the railroads could save a million dollars a day. Other witnesses, managers of plants, swore that through Scientific Management they had reduced their costs, while increasing their men's wages *25 to 100 per cent.*

Scientific Management! In common with the public in general, reporters and editors of the non-technical press never had heard of it before, and it seemed a phrase to conjure with. And a saving of a million dollars a day! That was truly sensational.

Among the reporters of the special type who were present when this testimony was given was Ray Stannard Baker; and in referring to it in an article published the following March in *The American Magazine,* he said:

> To those who heard this testimony there seemed at first something almost magical about the new idea; but as one sober, hard-headed business man after another testified as to what had been actually accomplished in his plant, when it appeared that Scientific Management had been applied with extraordinary results to widely diversified industries, from steel plants to bleacheries and cotton mills, and including railroad repair shops, the spirit of incredulity changed to one of deep interest. Another factor in carrying conviction to the hearers was the extraordinary fervor and enthusiasm expressed by every man who testified. Theirs was the firm faith of apostles: it was a philosophy which worked, and they had the figures to show it.
>
> "This," said Mr. Commissioner Lane to one of the witnesses, "has become a sort of substitute for religion with you."

All through the testimony about Scientific Management, one man was referred to as its originator and principal exponent. Though Brandeis had visited him several times to get information, this man had done nothing, directly or indirectly, to prompt the introduction of the Scientific Management idea at those rate hearings, and he himself did not appear, but again and again his name came up. And it was in that way that Frederick W. Taylor, to some extent, at least, became known to the generality.

The effect of the insertion of the scientific management argument into the rate hearings contest was felt almost instantaneously by the whole country. Only a few days after the introduction of the evidence, the early December reviews of current events gave great space to the dramatic testimony of some of the witnesses. By January, one of the leading railroad journals had begun a series of articles in which the railroads were defended against the implication that they were inefficiently managed. And through January, February, March and every month of 1911, the periodical press, popular as well as technical, was filled with explanation after explanation as to what scientific management is, why it is good, or why it is worthless. By the fall of 1911, Dartmouth College had arranged for a conference to spread information as to the merits of scientific management; while on the other hand, owing to the demands of organized labor, a special House committee was inquiring as to whether Congress should forbid the system in the government service.[1]

III

Taylor's most heroic attempt to elucidate the philosophy of Scientific Management in a popular way was that which he made when testifying in January, 1912, before the Special Investigating Committee of the House of Representatives whose appointment was due to pressure on Congress brought by organized labor.

We shall here quote liberally from this testimony,[2] not only because of the light it will throw on the general aims toward which all his workaday activities were directed from his early youth, but also because it is racy with the flavor of his personality.

The beginning of his testimony he devoted to showing (1) that labor's traditional opposition to all labor-saving devices was due to its " honest ignorance " of the " underlying truths of political economy," and (2) that in latter days working people had found an additional reason for restricting their output in their experiences with the piece-rate system under

[1] Horace B. Drury, *Scientific Management, Columbia University Studies in History, Economics and Public Law.*

[2] The report of it is contained in Volume 3, *Hearings Before Special Committee of the House of Representatives To Investigate the Taylor and other Systems of Shop Management;* Government Printing Office, 1912. The words of Taylor's we have omitted as signified by dots are those he used when markedly repeating himself. To an unusual degree, Taylor writing and Taylor talking were different persons. When he wrote, he habitually chose his words and constructed his sentences with exceeding care; when he spoke, he, equally as a matter of habit, just let himself drive.

which their reward for increasing their production was usually a cut in the rate. Taking up his particular subject, he said:

There are many elements of scientific management . . . that are utterly impossible to go into at a hearing of this kind; but I want . . . to make clear what may be called the essence of it, so that when I use the words "scientific management," you men who are listening may have a clear, definite idea of what is in my mind. . . . I want to clear the deck, sweep away a good deal of rubbish first by pointing out what scientific management is not. . . .

Scientific management is not any efficiency device . . . nor is it any bunch or group of efficiency devices. It is not a new system of figuring costs; it is not a new scheme of paying men; it is not holding a stop watch on a man and writing things down about him; it is not time study; it is not motion study nor an analysis of the movements of men; it is not the printing and ruling and unloading of a ton or two of blanks on a set of men and saying, "Here's your system; go to it." It is not divided foremanship or functional foremanship; it is not any of the devices which the average man calls to mind when scientific management is spoken of. . . . I am not sneering at cost-keeping systems, at time study, at functional foremanship, nor at any new and improved scheme of paying men, nor at any efficiency devices, if they are really devices that make for efficiency. I believe in them; but what I am emphasizing is that these devices in whole or in part are not scientific management; they are useful adjuncts to scientific management, so are they also useful adjuncts of other systems of management.

Now, in its essence, scientific management involves a complete mental revolution on the part of the workingman engaged in any particular establishment or industry — a complete mental revolution on the part of these men as to their duties toward their work, toward their fellow men, and toward their employers. And it involves the equally complete mental revolution on the part of those on the management's side — the foreman, the superintendent, the owner of the business, the board of directors — a complete mental revolution on their part as to their duties toward their fellow workers in the management, toward their workmen, and toward all of their daily problems. And without this complete mental revolution on both sides scientific management does not exist.

That is the essence of scientific management, this great mental revolution. Now, later on, I want to show you more clearly what I mean by this great mental revolution. I know that it perhaps sounds to you like nothing but bluff — like buncombe — but I am going to try and make clear to you just what this great mental revolution involves, for it does involve an immense change in the minds and attitude of both sides.

In the past, he said, a great part of the thought and interest both of management and workmen had been "centered upon what may be called the proper division of the surplus resulting from their joint efforts," so that gradually the two sides had come "to look upon one another as antagonists, and at times even as enemies." Continuing, he said:

The great revolution that takes place in the mental attitude of the two parties under scientific management is that both sides take their eyes off of the division of the surplus as the all-important matter, and together turn their attention toward increasing the size of the surplus. . . . They both realize that when they substitute friendly cooperation and mutual helpfulness for antagonism and strife they are together able to make this surplus so enormously greater than it was in the past that there is ample room for a large increase in wages for the workmen and an equally great increase in profits for the manufacturer. . . . It is along this line . . . of the substitution of peace for war; the substitution of hearty brotherly coöperation for contention and strife; of both pulling hard in the same direction instead of pulling apart; of replacing suspicious watchfulness with mutual confidence; of becoming friends instead of enemies; it is along this line, I say, that scientific management must be developed.

This change in the mental attitude of both sides toward the "surplus" is only a part of the great mental revolution which occurs under scientific management. I will later point out other elements of this mental revolution. There is, however, one more change in

> viewpoint which is absolutely essential to the existence of scientific management. Both sides must recognize as essential the substitution of exact scientific investigation and knowledge for the old individual judgment or opinion, either of the workman or the boss, in all matters relating to the work done in the establishment. And this applies both as to the methods to be employed in doing the work and the time in which each job should be done.
>
> Scientific management cannot be said to exist, then, in any establishment until after this change has taken place in the mental attitude of both the management and the men, both as to their duty to coöperate in producing the largest possible surplus and as to the necessity for substituting exact scientific knowledge for opinions or the old rule of thumb or individual knowledge.
>
> These are the two absolutely essential elements of scientific management.

It had become his practice to compare Scientific Management with what he regarded as the best of other types; namely, the "management of initiative and incentive," under which it was sought to capture the worker's initiative and best efforts by offering in good faith such an incentive as a high wage for day work, a liberal piece-rate, or a share in the profits. After interpreting on the witness stand this best of other types, Taylor went on:

> The first great advantage which scientific management has over the management of initiative and incentive is that under scientific management the initiative of workmen — that is, their hard work, their good will, their ingenuity — is obtained practically with absolute regularity, while under even the best of the older types of management this initiative is only obtained spasmodically and somewhat irregularly. This obtaining, however, of the initiative of the workmen is the lesser of the two great causes which make scientific management better for both sides than the older type of management. By far the greater gain under scientific management comes from the new, the very great and the extraordinary burdens and duties which are voluntarily assumed by those on the management's side.

These new burdens and new duties are so unusual and so great that they are to the men used to managing under the old school almost inconceivable. These duties and burdens voluntarily assumed under scientific management by those on the management's side, have been divided and classified into four different groups and these four types of new duties assumed by the management have (rightly or wrongly) been called the "principles of scientific management."

The first of these four groups of duties taken over by the management is the deliberate gathering in on the part of those on the management's side of all of the great masses of traditional knowledge, which in the past has been in the heads of the workmen, and in the physical skill and knack of the workmen, which he has acquired through years of experience. The duty of gathering in of all this great mass of traditional knowledge and then recording it, tabulating it, and, in many cases, finally reducing it to laws, rules and even to mathematical formulae, is voluntarily assumed by the scientific managers. And later, when these laws, rules and formulae are applied to the everyday work of all the workmen of the establishment, through the intimate and hearty coöperation of those on the management's side, they invariably result, first, in producing a very much larger output per man, as well as an output of a better and higher quality; and, second, in enabling the company to pay much higher wages to their workmen; and, third, in giving to the company a larger profit.[1] The first of these principles, then, may be called the development of a science to replace the old rule of thumb knowledge of the workmen; that is, the knowledge which the workmen had, and which was, in many cases, quite as exact as that which is finally obtained by the management, but which the workmen nevertheless in nine

[1] Though Taylor here spoke only of the gain arising from Scientific Management to employer and employee, the fact is that he regarded the interest of the general public as paramount. In a letter written in 1911, he said: "Most of us see only two parties to the transaction, the workmen and their employers. We overlook the third great party, the whole people, the consumers, who buy the product of the first two and who ultimately pay both the wages of the workmen and the profits of the employers. The rights of the people are therefore greater than those of either employer or employee. And this third great party should be given its proper share of any gain. In fact, a glance at industrial history shows that in the end the whole people receive the greater part of the benefit coming from industrial improvements."

hundred and ninety-nine cases out of a thousand kept in their heads, and of which there was no permanent or complete record.

The second group of duties which are voluntarily assumed by those on the management's side under scientific management is the scientific selection and then the progressive development of the workmen. It becomes the duty of those on the management's side to deliberately study the character, the nature, and the performance of each workman with a view to finding out his limitations on the one hand, but even more important, his possibilities for development on the other hand; and then, as deliberately and as systematically to train and help and teach this workman, giving him, wherever it is possible, those opportunities for advancement which will finally enable him to do the highest and most interesting and most profitable class of work for which his natural abilities fit him, and which are open to him in the particular company in which he is employed. This scientific selection of the workman and his development is not a single act; it goes on from year to year and is the subject of continual study on the part of the management.

The third of the principles of scientific management is the bringing of the science and the scientifically selected and trained workman together. I say " bringing together " advisedly, because you may develop all the science that you please, and you may scientifically select and train workmen just as much as you please, but unless some man or some men bring the science and the workman together all your labor will be lost. We are all of us so constituted that about three-fourths of the time we will work according to whatever method suits us best; that is, we will practice the science or we will not practice it; we will do our work in accordance with the laws of the science or in our own old way, just as we see fit, unless some one is there to see that we do it in accordance with the principles of the science. Therefore I used advisedly the words " bringing the science and the workmen together." It is unfortunate, however, that this word " bringing " has rather a disagreeable sound, a rather forceful sound; and, in a way, when it is first heard it puts one out of touch with what we have come to look upon as the modern tendency. The time for using the word " bringing " with the sense of forcing, in relation to most matters, has gone by; but I think I may soften this word down in its use in this particular case by saying that nine-tenths of the trouble with those of us who have been engaged in helping people to change from the older type of management to the new management — that is, to scientific management — that nine-tenths of our trouble has been to "bring" those on the management's side to do their fair share of the work and only one-tenth of our trouble has come on the workman's side. Invariably we find very great opposition on the part of those on the management's side to do their new duties and comparatively little opposition on the part of the workmen to co-operate in doing their new duties. So that the word "bringing" applies much more forcefully to those on the management's side than to those on the workman's side.[1]

The fourth of the principles of scientific management is perhaps the most difficult of all the four principles of scientific management for the average man to understand. It consists of almost equal division of the actual work of the establishment between the workmen, on the one hand, and the management on the other hand. That is, the work which under the old type of management practically all was done by the workman, under the new is divided into two great divisions, and one of these divisions is deliberately handed over to those on the management's side.[2] This new division of work, this new share of the work assumed by those on the management's side, is so great that you will, I think, be able to understand it better in

[1] That the "new burdens and duties" Taylor placed on management were so great as to be "almost inconceivable" to managers of the old school, will be the more clear when it is considered that all along it had been held with practical unanimity that the details of labor operations were things to be left almost entirely to the judgment of those who actually did the work or who practiced the trade with which the operations were connected. This is seen in the philosophy of "initiative and incentive" which, whatever the incentive offered the workmen, involved putting up to them practically all of the problems pertaining to the selection of their implements and methods. On the other hand, the duty placed on management by Taylor of reducing work to a science involved its assuming the responsibility for all implements and methods — a very revolutionary proceeding indeed.

[2] Taylor here had reference to his separation of planning from execution, and his concentration of planning in a special department of management — a sweeping division of duty which, as we shall see, necessarily led to still further divisions and sub-divisions, and so brought about all the phenomena represented by the functional type of organization.

a numerical way when I tell you that in a machine shop, which, for instance, is doing an intricate business — I do not refer to a manufacturing company, but, rather to an engineering company; that is, a machine shop which builds a variety of machines and is not engaged in manufacturing them, but, rather, in constructing them — will have one man on the management's side to every three workmen; that this immense share of the work — one-third — has been deliberately taken out of the workmen's hands and handed over to those on the management's side. And it is due to this actual sharing of the work between the two sides more than to any other element that there has never (until this last summer) been a single strike under scientific management.[1] In a machine shop, again, under this new type of management there is hardly a single act or piece of work done by any workman in the shop which is not preceded and followed by some act on the part of one of the men in the management. All day long every workman's acts are dovetailed in between corresponding acts of management. First, the workman does something, and then a man on the management's side does something; and then the workman does something; and under this intimate, close personal coöperation between the two sides it becomes practically impossible to have a serious quarrel.

Of course I do not wish to be understood that there are never any quarrels under scientific management. There are some, but they are the very great exception, not the rule. And it is perfectly evident that while the workmen are learning to work under this new system, and while the management is learning to work under this new system, while they are both learning, each side to coöperate in this intimate

[1] Not only was Taylor personally successful in winning the coöperation of working people, but the same thing was true of the engineers who worked under his general direction or who followed his methods. The only thing in the nature of a labor flurry that ever occurred in any establishment with which he, directly or indirectly, had anything to do was at the Watertown (Massachusetts) Arsenal in 1911, and it was to this that he had reference on the stand. At this government plant the workers were subjected to an organized outside agitation due to the prominence given to Scientific Management at the railway-rate hearings, but we shall see that the seven-days' strike hardly would have occurred even then had it not been for overhasty steps taken by officers at the arsenal in clear violation of what may be called Taylor's technic of installation.

way with the other, there is plenty of chance for disagreement and for quarrels and misunderstandings, but after both sides realize that it is utterly impossible to turn out the work of the establishment at the proper rate of speed and have it correct without this intimate, personal coöperation, when both sides realize that it is utterly impossible for either one to be successful without the intimate, brotherly coöperation of the other, the friction, the disagreements, and quarrels are reduced to a minimum. So I think that scientific management can be justly and truthfully characterized as management in which harmony is the rule instead of discord.

In his paper *The Principles of Scientific Management* (p. 36), Taylor summed up the new duties put upon managers by his system as follows:

..*First.* They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.

Second. They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.

Third. They heartily coöperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.

Fourth. There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

Further on in this same paper (p. 130) we read:

Scientific management, in its essence, consists of a certain philosophy, which results, as before stated, in a combination of the four great underlying principles of management.

In a footnote, these principles are defined as follows:

First. The development of a true science. *Second.* The scientific selection of the workman. *Third.* His scientific education and development. *Fourth.* Intimate friendly coöperation between the management and the men.

It is evident from this, as well as from the addresses he delivered later, that Taylor not only failed to discriminate between duties and principles, but also failed sharply to distinguish his principles one from another. This, however, but bespeaks his lack of skill in formulation.

> In the progress of human knowledge [says the *Standard Dictionary*] a science, in its earliest and simplest form, is usually a mere collection of observed facts. . . . The next step is to correlate or generalize these facts forming a system . . . ; the next to formulate these generalizations as laws . . . ; the final step, to proceed to some principle or force accounting for these laws.

It is when the latter two steps are taken that we enter the domain of pure theory, and here is work for the scientific philosopher as distinguished from the plain scientist.

That, when overtaken by death at fifty-nine, Taylor was groping after the higher laws of life in general, is known by those who were his intimates. His modesty, his diffidence in the presence of those laws, was marked and touching. Undoubtedly he never would have attempted to deal with the philosophy even of his own system of management had he not been forced to it. And the probabilities are that he never would have been at home in the domain of pure theory, his mind having been too long directed to the observation of tangible facts.

Again it may be said that the science of management remained during his lifetime too young for *anyone* to formulate its principles definitely, systematically, and comprehensively.

However imperfect Taylor's statement of his four principles may have been, we yet may read in them the course he had followed throughout.

"The development of a true science" implies the deliberation by which your problem is defined, the analysis by which it becomes known to you in detail, and the investigation and experimentation by which you gain the knowledge which the analysis shows you must seek.

"The scientific selection of the workman; his scientific education and development," or "bringing the science and the workman together; intimate, friendly coöperation between management and man" — all this implies the standardization, systemization, and organization by which the knowledge gained by the investigation and experimentation is turned to practical account.

And mayhap as we follow Taylor through the details of his life, it will become more and more manifest that herein is bound up a high development of that combination of technics and ethics which is now the hope, not only of Europe, but also of America.

BOOK I

ANCESTRY AND BOYHOOD

. . if we have inherited, not the Puritan heirlooms, but the living Puritan tradition, we enter into the modern spirit. By this phrase I mean, primarily, the disposition to accept nothing on authority, but to bring all reports to the test of experience. The modern spirit is, first of all, a free spirit open on all sides to the influx of truth, *even from the past*. But freedom is not its only characteristic. The modern spirit is marked, further, by an active curiosity, which grows by what it feeds upon, and goes ever inquiring for fresher and sounder information, not content till it has the best information to be had anywhere. But since it seeks the best, it is, by necessity, also a critical spirit, constantly sifting, discriminating, rejecting, and holding fast that which is good, only till that which is better is within sight. This endless quest, when it becomes central in a life, requires labor, requires pain, requires a measure of courage; and so the modern spirit, with its other virtues, is an heroic spirit. As a reward for difficulties gallantly undertaken, the gods bestow upon the modern spirit a kind of eternal youth, with unfailing powers of recuperation and growth.

To enter into this spirit is what the Puritan means by freedom. He does not, like the false emancipator, merely cut us loose from the old moorings and set us adrift at the mercy of wind and tide. He comes aboard, like a good pilot; and while we trim our sails, he takes the wheel and lays our course for a fresh voyage. His message when he leaves us is not, "Henceforth be masterless," but, "Bear thou henceforth the sceptre of thine own control through life and the passion of life." If that message still stirs us as with the sound of a trumpet, and frees and prepares us, not for the junketing of a purposeless vagabondage, but for the ardor and discipline and renunciation of a pilgrimage, we are Puritans.

Stuart P. Sherman,
What Is a Puritan? Atlantic Monthly,
September, 1921

CHAPTER I

THE TAYLOR AND WINSLOW FAMILIES

SAYS Robert Louis Stevenson in writing about the engineer, Fleeming Jenkin: "Not only do our character and talents lie upon the anvil and receive their temper during generations; but the very plot of our life's story unfolds itself on a scale of centuries, and the biography of the man is only an episode in the epic of the family." This has special applicability to Frederick Winslow Taylor.

Born March 20, 1856, in Germantown, which, though then a decidedly rural community, had been annexed two years before to the city of Philadelphia, he was the second of the three children who were the issue of the marriage of Franklin Taylor and Emily Annette Winslow.

In the case of each of these parents of Frederick Taylor we have a family history truly epical. Both were born in 1822; the father in Bristol township, Bucks county, Pennsylvania, and the mother in Havre, France, where her parents were living for the time being. Franklin Taylor was descended from an English Quaker who settled in the region of the lower Delaware River in 1677. Emily Winslow was descended from an English Puritan who settled in Plymouth, Massachusetts, in 1629. Franklin Taylor was of the fourth generation of his family to be born on American soil. His wife, the circumstance of her having been born in France notwithstanding, was of the sixth generation of Winslows to be born here.

Though that fusion of races which is present-day America began in the earliest Colonial times, it would appear from all we can gather that both Franklin Taylor's and Emily Winslow's ancestries were in collateral as well as line simon-pure English, a fact that may be of interest in connection with Frederick Taylor's marked qualities of sportsmanship and persistence.

The epic of Franklin Taylor's family is the epic of the lower Delaware, or that of the planting of Quakerism in America. The epic of Emily Winslow's family is the epic of New England, or that of the planting of Puritanism in America. Since Quakerism is an off-shoot of Puritanism, these epics are closely allied. The early history of New England is, in truth, bound up with the development of Quakerism in America; and the fact is that a direct ancestor of Emily Winslow's, one James, who was of the second generation of Winslows to be born here, became a Quaker, and Quakerism continued in this branch of the family down to Emily Winslow's time.

Now, in *The Theory and Practice of Scientific Management*, C. Bertrand Thompson says:

> . . . scientific management is the extension to industrial organization of the "positive" movements in current thought. The substitution of a basis of scientific law and principles for guesswork or tradition reminds one strongly of Auguste Comte's theory of progress from the "theological," through the "metaphysical," to the "positive" or scientific stage of thought.

We believe that this celebrated Comtean hypothesis of the "Three Stages," if its terms are understood as Comte himself defined them, and if it is taken to represent all that he included in it, has been proved untenable, but that it nevertheless contains "an adumbration of the truth." Which is to say, briefly, that as theological and metaphysical ways of philosophizing (arriving at generalizations) do not recognize the *necessity for verification*, the scientific way, which does fully recognize this necessity, is an advance over the former two. This advance, we think, is well illustrated in the Puritan epics of the Taylor and Winslow families.

It behooves us now to grasp the meaning of Puritanism in all its forms. This we can best do by permitting John Fiske [1] to take us back to the eighth century, when from Armenia there came into Thrace a sect that in the Bulgarian tongue was known as Bogomilians, or men constant in prayer, and in Greek as Cathari or Puritans; this Greek word Cathari having its root in *katharos*, pure, from which we derive our English word cathartic. The idea, you see, is that of purification through purging. "Of the more obscure pages of mediaeval history," says Fiske, "none are fuller of interest than those in which we decipher the westward progress of these sturdy heretics through the Balkan peninsula into Italy, and thence into southern France, where toward the end of the twelfth century we find their ideas coming to full blossom in the great Albigensian heresy." It was in the fourteenth century that Puritanism spread to England, and at first the people who there became infected with it were dubbed Lollards, a word derived from the Dutch signifying babblers, or mumblers of prayers. As they had no doctrines held in common, these Lollards hardly can be called a sect. "The name by which they were known," says Fiske, "was a nickname which might cover almost any amount of diversity in opinion, like the modern epithets 'freethinker' and 'agnostic.' The feature which characterized the Lollards in common was a *bold spirit of inquiry*." The italics are ours. This is indeed the origin of Puritanism in all its forms.

The constant prayer of the Puritan represents an attempt to open the mind to the influx of truth, and to steel the character to bear the truth and testify to it in one's actions. The purgative idea represents the casting out of preconceptions, predispositions, bad habits, ill humors, and evil affections that interfere with the influx of truth. Hence in all lands and in all ages Puritanism stands for the modern spirit, or the pro-

[1] See *The Beginnings of New England*, ch. I.

gressive, adventurous, crusading, heroic spirit of immortal youth.

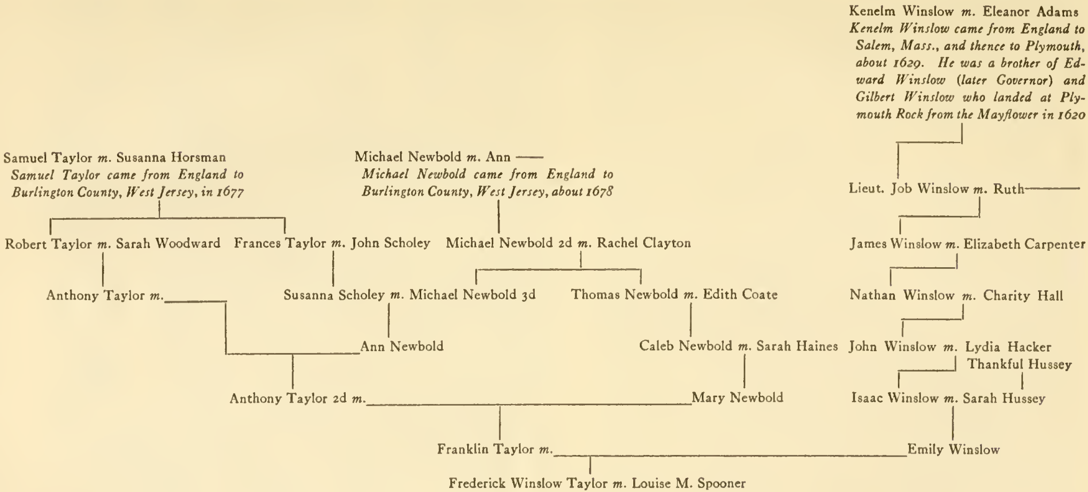
Frederick Taylor's ancestors manifested their bold spirit of inquiry mainly in the field of religion. His was concentrated in the field of industry.

Among the later generations of his ancestors we may discern an increasing skepticism concerning what is called "revealed" religion. This we may attribute to the growing perception in their later times of the *necessity for verification.*

As a matter of fact, the tendency of Puritanism from the beginning was to make men use their brains, and this tendency was accentuated by the impress left upon Puritanism in the sixteenth century by John Calvin. True, Calvin substituted for an infallible church an infallible book, but by that very token were men compelled to read and study the book. "And much earlier than is generally recognized," says Stuart P. Sherman, "the Puritan mind began to appeal from the letter to the spirit of Scripture, from Scripture to scholarship, and from scholarship to the verdict of the philosophic reason."

Said John Robinson, the pastor, in Leyden, of the Pilgrims who landed at Plymouth Rock in 1620: "All truth is of God. . . . Whereupon it followeth that nothing in right reason and sound philosophy can be false in divinity." Cotton Mather, too, wrote in his diary in 1711: "There is a thought which I have often had in my mind; but I would now lay upon my mind a charge to have it oftener there: that the light of reason is the law of God; the voice of reason is the voice of God. . . . Let me as often as I have evident reason set before me, think upon it; the great God now speaks to me." And here is something still more interesting:

> There was a Boston boy of Puritan ancestry, who had sat under Cotton Mather's father [Increase Mather, president of Harvard College], who had heard Cotton Mather preach in the height of his power, and who said years afterward that reading Cotton Mather's



GENEALOGY OF FREDERICK WINSLOW TAYLOR

book, *Essays to do Good,* "gave me such a turn of thinking as to have an influence on my conduct through life; for I have always set a greater value on the character of a *doer of good,* than on any other kind of a reputation; and if I have been . . . a useful citizen, the public owes the advantage of it to that book." This boy had a strong common sense. To him, as to Mather, right reason seemed the rule of God and the voice of God.

He grew up in Boston under Mather's influence, and became a free-thinking man of the world, entirely out of sympathy with strait-laced and stiff-necked upholders of barren rites and ceremonies. I am speaking of the greatest liberalizing force in eighteenth-century America, Benjamin Franklin. Was he a Puritan? Perhaps no one thinks of him as such. Yet we see that he was born and bred in the bosom of Boston Puritanism; that he acknowledged its greatest exponent as the prime inspiration of his life. Furthermore, he exhibits all the essential characteristics of the Puritan: dissatisfaction, revolt, a new vision, discipline, and a passion for making the new vision prevail.[1]

A little later we shall have occasion to bring out even more clearly the remarkable resemblance between the mental attitude of Benjamin Franklin and that of Frederick Taylor. For the present it need only be said that in Frederick Taylor the necessity for verification, which is the marked characteristic of the scientific stage of thought, became paramount.

The Puritans of the seventeenth and eighteenth centuries were distinguished, not only by their bold spirit of inquiry and their sturdy independence of character, but also by their imperious insistence upon obedience to law as they understood it. With the coming of the nineteenth century the zeal of the Puritan generally began to lapse. In Frederick Taylor, born in the middle of the nineteenth century, this zeal suddenly blazed up anew.

Now, it would appear that, despite all the wealth of detail

[1] Stuart P. Sherman, "What Is a Puritan?"

of mechanism and method brought in modern times to their study, the processes of heredity remain mostly a secret; it being said by biologists that individuality depends on a *chance* combination of hereditary factors. However, it may help to explain Frederick Taylor if we take into consideration the principle of atavism, or the restoration of that which has been lost or obscured, by the "reversion, through the influence of heredity, to ancestral characters," sometimes remote.

Of his father and mother, the mother had the stronger character, and apparently it was through her that he acquired most of his characteristics. Nevertheless, we shall follow the conventional order and deal with his father's family first.

The first settlement made by the Quakers in this country was at Salem, on the Delaware River, in what was then the province of West Jersey, in 1675. Soon thereafter they effected another settlement at Burlington, also on the Delaware, but many miles farther north, and to this place in 1677 came in the flyboat Martha a youth named Samuel Taylor, born in the parish of Dore, county Derby, England.

We read in Francis B. Lee's *Genealogical and Memorial History of the State of New Jersey* that by his elder brother William, who had arrived previously, there was conveyed to this Samuel Taylor one thirty-second of a share in the province, and that Samuel eventually had surveyed for himself a part of it lying in Chesterfield township, Burlington county, where he settled, married, had nine children, and died.

Families are queer things. With every marriage comes an infusion of new blood; and how can you deny that this new blood is not just as important as the old? What we call the new blood is the wife's; but, as a matter of fact, why is it any more new than the husband's? Samuel Taylor, for example, married a Susanna Horsman, and by her had a son, Robert, who married a Sarah Woodward. Then this Robert Taylor and Sarah Woodward had a son, Anthony, who married an Anne Newbold, and by her had a son, Anthony, 2nd, who in turn married a Mary Newbold, and by her had a son, Franklin, who was the father of the subject of this biography. Taking, then, this man Franklin Taylor, we may ask why he was any more a Taylor than he was a Horsman. All of which is to say that if, through your parents, you are the descendant of two families, you through your grandparents are the descendants of four, and through your great-grandparents of eight, and so on until it would appear that your ancestry merges into that of all men. Looked at in this way, pride in a particular family truly becomes ridiculous; and one thing certain is that if Frederick W. Taylor ever had any interest whatsoever in his ancestry, it never was revealed so that anyone could notice it. Genealogy was one science that failed to make any appeal to him.

Still, there is a great deal in family, especially when there are in a particular family records and traditions that are handed down from generation to generation, since such records and traditions are likely to have a great influence upon a child while he is yet in his most impressionable years. In this Taylor family, for example, there was a tradition of loyalty. It was said again and again that a Taylor is loyal. Who, then, can doubt that, wholly apart from any question of its being in his blood, the spirit of loyalty was in a Taylor child's environment, there to act upon him as a powerful, character-forming suggestion? This, indeed, brings us to the fact, quite important in accounting for Frederick Taylor, that "man differs markedly from other animal species in having two kinds of inheritance. He has a biological inheritance — this is his real heredity, inherent in him, and responsible for much of his physical and mental condition. . . . He has also a social inheritance, not a part of his heredity, but playing a very important and conspicuous rôle in his life, especially in his less material, his higher life.

. . . This social inheritance consists of tradition, of recorded history, of precept and example."[1]

In Great Britain, where the right of primogeniture still is maintained, the duty of upholding the family traditions devolves chiefly upon the eldest son. It would appear, however, that Samuel, the founder of this Taylor family in America, selected for this duty the youngest of his nine children. At all events, this youngest child, Robert, was the executor of his father's will, and it was he who inherited from the homestead tract the 500 acres that under the name of Brookdale Farm was destined to become locally historic.

In a return to the British manner, Anthony, the eldest son of Robert Taylor, fell heir to Brookdale at his father's death, and all of his six children were born there. Though a Quaker, this Anthony Taylor became an ardent patriot when the American colonies revolted against Great Britain, and in consequence of his services to the Revolution, Brookdale was laid waste by the British. It is interesting to note that the Anne Newbold whom this Anthony Taylor married was his first cousin paternal, and that his third son, Anthony, 2nd, grandfather of Frederick Taylor, also married a Newbold.

Of Anthony Taylor, 2nd, it is stated in Francis B. Lee's history that "in accordance with the directions given in his father's will, he was kept at school until after he was fifteen years of age, and was then [apparently in 1787] apprenticed to John Thompson, a prominent merchant of Philadelphia, to be trained for a mercantile and business career. Here he remained until he became of age, when he formed a partnership with Thomas Newbold, who later became his brother-in-law, and under the firm name of Taylor and Newbold they engaged in an extensive trade with the East Indies."

Apparently this Anthony Taylor quickly accumulated a

[1] Vernon Kellogg, "The Biologist Speaks of Death," *Atlantic Monthly*, June, 1921.

fortune in this trade, and in the light of his distinguished grandson's course, we find it interesting to read that in 1810, when he was only thirty-eight years old, he retired from active business, to settle at "Sunbury," the country seat of 400 acres which he had purchased several years before; this being situated in Bristol township, Bucks county, Pennsylvania, just across the Delaware River from his ancestral acres in Burlington county, New Jersey. Evidently Benjamin Franklin was not the only early Philadelphian by adoption who, for all his thrift, held it to be disgraceful to go accumulating riches up to one's death. However, we do not have to attribute Anthony Taylor's course to the influence of Franklin, since Anthony Taylor was a Quaker, and few things could be more inconsistent with Quaker principles than to lust after great wealth. If it remains to this day a characteristic of Philadelphians in general to frown upon ostentatious wealth, it may be attributed to Philadelphia's Quaker origin.

After his retirement from business Anthony Taylor appears to have put more and more of his money into the land of lower Bucks county, and it is said that at the time of his death he was the largest landowner in the county. He was one of the organizers of the Farmers' National Bank of Bristol, and served as its president for several years. By Mary Newbold Taylor he had no less than eleven children, and of these Franklin Taylor was the youngest; Franklin being born when his father was fifty.

We have seen that the marriage of Anthony Taylor and the marriage of his son Anthony, 2nd, each was to a Newbold. Though the Newbold family apparently during three of its generations in America remained attached to the Church of England, the Newbolds also were among the earliest settlers of Quaker West Jersey; Michael Newbold, the founder of the family in America, coming over with his wife and nine of his eleven children sometime between 1678 and 1681. In 1685 he

AN EARLY FAMILY GROUP

Left to right: Frederick Winslow Taylor, Isaac Winslow (*grandfather*), Edward Winslow Taylor (*brother*), Franklin Taylor (*father*), Emily Winslow Taylor (*mother*), Mary Newbold Taylor (*sister*, later Mrs. Clarence M. Clark)

acquired a tract of 450 acres in Burlington county, and this property has continued in the uninterrupted ownership of the Newbold family ever since.

From the start the Newbolds were extensive purchasers of land and operators in real estate. They also were conspicuously men of public spirit. Michael, 2nd, was one of the justices of Burlington county, and his son, Thomas, held various public offices. Though not a Quaker, this Thomas Newbold became a trustee of the Chesterfield Monthly (Friends') Meeting, and his children, their mother being a Quaker, were accounted birthright Friends. It was Caleb Newbold, a son of Thomas, from whom Newbold's Island, in the Delaware just below Bordentown, got its name. Then known as Biddle's Island, Caleb Newbold bought it for his home, and it was there that his daughter Mary, the mother of Franklin Taylor, was born. Other Newbolds settled in Philadelphia, to play leading parts as merchants, importers, brokers, lawyers, journalists and other professional people.

Through his mother, Frederick Taylor came about as near being what is ordinarily meant by a Mayflower descendant as anyone well could be without being it exactly. Which is to say that while Emily Annette Winslow was not descended from either the Edward or the Gilbert Winslow who landed from the Mayflower at Plymouth Rock in 1620, she *was* descended from the Kenelm Winslow who was a brother of Edward and Gilbert, and in all probability landed from this same ship Mayflower, but at Salem, Massachusetts Bay, in 1629.

In the *Winslow Memorial*, a genealogical work of two large volumes published in 1877 by Dr. and Mrs. David Parsons Holton, we read that Edward Winslow was one of the fifteen Mayflower Pilgrims "who were accompanied by either children or servants, and one of the eight that bore the honorable distinction of 'Mr.'" This means that, in the caste system of old England, these Winslows were of the gentry. With ambition more or less praiseworthy, Dr. and Mrs. Holton struggled to trace the genealogy of this family back to the fourteenth century. What is clearly established is that Kenelm Winslow who died in the parish of St. Andrew, Worcestershire, in 1607, had a son Edward, who was born in that parish in 1560, and that this Edward Winslow, whose home was in Droitwich, Worcestershire, was the father of the five Winslow brothers, Edward, John, Kenelm, Gilbert, and Josiah, all of whom came to America.

It was while traveling on the continent of Europe in 1617 that Edward, the oldest of the brothers, became acquainted with John Robinson, and was so influenced by that great man that he joined the Pilgrims' congregation then and there. After William Bradford, he was for many years the governor of Plymouth Colony, and several times was sent back to England by this colony to represent its interests there. Kenelm Winslow, the direct ancestor of Frederick Taylor, was the third oldest of the five brothers. As already said, he probably landed from the Mayflower at Salem, Massachusetts Bay, in 1629, and this voyage of the Mayflower was a Puritan, in distinction to a Pilgrim, enterprise; a distinction, it will be observed, that dates back to the 1560's, or to a time early in the reign of Queen Elizabeth, when there shot out from the body of Puritans a sect that was not content even with Presbyterianism, but pressed on to Independency or what we in America now call Congregationalism. Despite the fact that Kenelm Winslow reached New England in Puritan company, there is reason to believe that he never was *of* that company, but proceeded forthwith to join the Pilgrims at Plymouth. It is certain that he was "admitted freeman" of Plymouth in 1632.

Most of the early New England Winslows, it would appear, were skilled in some handicraft; and of Kenelm we read that though he usually was called a "planter," and was "somewhat engaged in the shipping interests," he also was styled "joiner." Now, Kenelm begat, among numerous others, "Lieutenant" Job Winslow, who served Plymouth in the Indian wars and was a shipwright by occupation; and Lieutenant Job begat, again among numerous others, one James Winslow, who, born in Freetown, Massachusetts, in 1687, "removed to Falmouth [near Portland], Maine, about 1728, and settled on the Presumpscot River, where he had granted to him in 1728 a tract of land on the back coast, on which to erect a mill." And of this James Winslow, who was of the second generation born on American soil, we also find set forth in the *Winslow Memorial* that "he was the first Friend [Quaker] in Falmouth"; to which is added from the *History of Portland* that he "lent a most important support to the doctrines of that respectable people in this neighborhood."

In what year was published this *History of Portland* which refers to the Quakers as being respectable, we do not know; but as it so often happens that the disreputables, the radicals, and the heretics of one generation become the respectables, the conservatives, and the orthodox of the very next, we may assume that, even as early as 1728, the respectability of the Quaker, if not fully established, was in a high degree inchoate. Still, in that year Quakerism probably was not so respectable in that isolated community in Maine that it did not take some force of character for James Winslow to be the first to introduce it there and lend it his "important support."

After James Winslow, at least three of his seven children, Nathan, James, and Benjamin, became members of the Society of Friends. Now, this eldest son, Nathan, residing in that part of old Falmouth which now is Westbrook, and there building himself a house which continued in his family for at least a hundred years, took unto himself a wife in the person of one Charity Hall, and by her had six sons and four daughters. And of these children, John, the fifth son, succeeded to the paternal estate, became a celebrated Quaker minister, and, as we find it recorded, "also a mechanic." Born in 1751, this minister-mechanic, who was the great-grandfather of Frederick W. Taylor, married in 1780 a Quaker maiden of Salem, Massachusetts, named Lydia Hacker, and went his father one better in rearing a family of the good old Hebrew patriarchal type; which is to say he had eleven children, all of whom reached maturity, and all of whom married, save one.

And all of this minister-mechanic's five sons, Jeremiah, Nathan, Isaac, Isaiah, and John, appear to have been unusually successful in business, especially the first three. Jeremiah and Isaac became so well known in fitting out vessels for the celebrated whale fishery of New Bedford, Massachusetts, that they soon were employed by the French Government to introduce the whale fishery in France. Nathan was a hardware merchant of Portland, Maine, and we read that "his powers of invention were considered remarkable." Also we read that he was "noted for both moral and physical courage. He was one of the earliest abolitionists in Portland, and for many years the most prominent abolition lecturers were entertained by him whenever they came to the city. His house was once surrounded by a mob on this account, when Stephen Foster took refuge there."

Contemporaneous with John Winslow, the minister-mechanic, in Portland and its vicinity was another and even more famous Quaker preacher, this latter one a woman. The Quakers were *very* advanced. As early as the seventeenth century they acquired the notion that the Lord can speak directly, not only to every man, but also to every woman. Thus among this extremely democratic body of worshipers, which is without a creed, a liturgy, a sacrament, or a regular priesthood, every woman is as free as every man to preach and to prophesy as the spirit moves her. And the only difference between a Quaker minister and the rest of the body is that the minister is publicly acknowledged to have the true gift of the light of God's spirit. Having had the reasonable, if unusual, maiden name of Thankful Purinton, the woman minister of Portland to whom we here are referring acquired through her marriage to one Samuel Fothergill Hussey, the quite unreasonable but none the less interesting name of Thankful Hussey, and as such she was known near and far; it being her custom, in sparsely-settled, eighteenth-century New England, to travel, unattended and on horseback, all the way from Portland, Maine, to Newport, Rhode Island, to preach en route at the Society of Friends' monthy, quarterly, and yearly meetings. And even as John Winslow, the minister-mechanic, was Frederick Taylor's great-grandfather, this forceful, gifted, self-reliant woman preacher was Frederick Taylor's great-grandmother. For Thankful Hussey had two daughters, one of whom, Comfort Hussey, was married to John Winslow's second son, Nathan, and the other of whom, Sarah Hussey, was married to John Winslow's third son, Isaac; this Isaac Winslow being Frederick Taylor's grandfather.

It has been said that Jeremiah and Isaac Winslow were employed to introduce the whale fishery in France. Jeremiah was born in 1781, and Isaac in 1788. Apparently these brothers with their wives went to France, to settle at Havre, soon after the close of the War of 1812. And it was at Havre in 1822 that Isaac Winslow's only child, Emily Annette, the mother of Frederick Taylor, was born. But whereas Jeremiah Winslow remained at Havre until his death in 1858, and all his descendants are now of the people of France and of Switzerland, Isaac Winslow returned to this country with his family in 1829.

Both Jeremiah and Isaac Winslow accumulated large fortunes for their day and generation, and both were known as men of high integrity. It is said that Isaac took several long voyages on his whaling vessels expressly for the purpose of studying into the life of the crews with a view to lessening their hardships. And as he designed not a few improvements in whaling apparatus, it would appear that he, as well as his brother Nathan, inherited powers of invention from his minister-mechanic father. And on the general score of his enterprising originality it may be mentioned that upon his return to this country in 1829, to settle at Danvers, Massachusetts, he was the first person to put corn up in tins for the market. He was an unusually kindly man. Like Cotton Mather, he made the doing of good a matter of systematic practice, and by persons still living he is remembered for that admirable complement of the observing eye, the ignoring eye; he never saw anything he was not supposed to see, and on account of this and his graciousness of manner in general, was adept in ironing out social kinks and smoothing over all kinds of awkward situations.

Not being brought by her parents to this country until she was seven, Emily Annette Winslow, greatly to the amusement of her numerous New England cousins, arrived here speaking English with a marked French accent. As she grew into young womanhood, however, there could not be the least doubt that here was a true daughter of New England Puritans and Quakers. Indeed, Thankful Hussey, she who had ridden early and late the long and lonely trails of primitive New England to testify that God had not died with the ancient Hebrews but still could speak to and through His children — that Quaker preacher, we say, might well have seen in this granddaughter of hers much of her own high spirit of self-reliance and brave belief in the plenitude of her own private inspiration. Parenthetically it may be said that if this Quaker preacher could have lived to witness the course in industry of her granddaughter's son, Frederick Taylor, she might have found in him a reincarnation, not only of all her intellectual power and strength of will, but also of her capacity to endure the disdain of the orthodox.

Different times, however, bring different manifestations of the spirit; and, curiously enough, self-reliance and independence in this Quaker preacher's granddaughter was destined largely to take the form of revolt against Quakerism itself — or rather against what in Quakerism had become narrowly and crampingly sectarian. As it acquired respectability, Quakerism paid what seems to be the inevitable price for such a luxury, in that it began to lose in missionary zeal. As early as the latter part of the eighteenth century Quakers as a body had begun to dwell with increasing emphasis on the peculiarities of dress and speech that tended to shut them off socially from their fellow men and women, and to rest so much upon a hard and rigorous discipline that the correction and exclusion of its members apparently became a larger part of its business than the preaching of its gospel.

An interesting example of this Quaker discipline is seen in the case of Emily Winslow's double first cousins, Louisa Maria, Lucy Ellen, and Harriet Winslow, the daughters of Nathan and Comfort Hussey Winslow (note the new nomenclature of the new generation). Louisa Maria and Lucy Ellen being married to non-Quakers, that settled them as far as the Falmouth Quarterly Meeting was concerned. And then the youngest sister, Harriet, took to dancing. This was too much. So there was circulated "A Lament for the Granddaughters of Thankful Hussey," which related how they had "wandered," been "stolen from," and had danced out of the "Quaker rest."

After her eldest sister's death, Harriet Winslow was married to this sister's widower, Samuel E. Sewall, who, attaining prominence at the Boston bar, at length settled in Melrose, Massachusetts. Apparently there was such deep sympathy between Emily Winslow and these double first cousins of hers that her relations with them resembled those of a sister. And as the Sewalls early became interested in that remarkable New England movement known as transcendentalism, Emily Winslow was privileged to meet the leaders of this movement, including Ralph Waldo Emerson and Bronson Alcott. Also she met Thoreau, Channing, Whittier, Wendell Phillips, William Lloyd Garrison, Julia Ward Howe, and Lydia M. Child.

What visions do these names call up of that plain living and high thinking, of that searching and torturing of conscience, of that din of debate and controversy, of that outburst of philanthropy, which was early nineteenth-century New England! Surely that was the period in which Puritanism's bold spirit of inquiry attained its apotheosis — in which, you might say, it went berserker! Not an individual vocation or a personal habit, much less any social institution, then escaped having question marks plastered all over it.

Every movement, of course, must have its "lunatic fringe," and far be it from us to associate with those New England gods and goddesses whose names we have just recorded, the pedantry, petulance, and puerility to which in New England the spirit of inquiry often descended. Let us remember, however, that none of those men and women at that time were any too respectable; that as Quakerism then and there acquired respectability, its place in public disesteem largely was taken by transcendentalism.

If Emily Winslow was not to be deterred from associating with transcendentalists by their lack of respectability, it is not to be supposed she had any interest in that movement's intellectual subtilities. To Puritan character in general and Quaker in particular there always has been two distinct sides, the mystical and the practical; and Emily Winslow was quite practical. Instinctively, no doubt, she felt the influence of all that which in transcendentalism lends support to the doctrine of self-reliance, and for her this meant definite action in the workaday world. So then it is not to be wondered at that, coming to maturity in those days of the full sunlight of New England's gods and goddesses, she mainly followed after those women of force and character, Lydia M. Child and Lucretia C. Mott, who toiled so indefatigably for the causes of woman suffrage and the abolition of human slavery. Frederick Taylor's mother, indeed, was among the earliest of the suffragists, and in 1842, when only twenty, she accompanied Lucretia Mott to London as a delegate to the International Anti-Slavery Convention. She also was associated with such prominent abolitionists as William Lloyd Garrison and Charles Sumner.

If in those days it took force of character to be a transcendentalist, it required still more to be an abolitionist. How had the pride of the Puritan fallen that New England — church, college, and press nearly complete — cowered for years before the threat of the slave traffic! To speak for the slave in those days you not only had to brook the anger of the "cultivated class," which was easy, but also face that brute force which lies at the bottom of society. In Illinois, the Rev. Mr. Lovejoy was repeatedly mobbed and burned out and finally shot dead for publishing a paper maintaining anti-slavery views; in Boston, William Lloyd Garrison was dragged through the streets with a rope about his neck.

About mankind there is nothing fixed; and as you view it in its different aspects (or as your mood varies), it now seems lovable and admirable, now hateful and mean. But while there is nothing fixed about mankind, we think that, after all, there does emerge from it, as you view it dispassionately, three classes — aristocratic, middle, and lower. But these classes are not composed as most people seem to think. What most people think is aristocratic really is middle, and vice versa. And these classes have little or nothing to do with money, or social position, or occupation. They are the classes Emerson saw: —

The terrible aristocracy that is in Nature. Real people dwelling with the real, face to face, undaunted: then, far down, people of taste, people dwelling in a relation, or rumor, or influence of good and fair, entertained by it, superficially touched, yet charmed by these shadows: — and, far below these, gross and thoughtless, the animal man.

That is to say, at the top such people as the *real* Puritans, with their "passion for *emancipating*," and emancipating, "not merely the religious and moral, but also the intellectual and the political and social capacities of man."

CHAPTER II

FREDERICK TAYLOR'S PARENTS

WHAT now should be plain is that among the lines represented by Frederick Taylor's ancestry there was, at least for America, an exceptional degree of *racial* and *spiritual* inbreeding, and that the marriage of his parents represented another union of the same racial and spiritual stocks. And with the inventiveness that had cropped out in his mother's line added to the old-fashioned zeal for righteousness inherent in the lines of both mother and father, may we not here have light thrown on how it was that his work in developing Scientific Management should include a high degree of both technics and ethics?

If we may be permitted a neologism from the vernacular, rather apposite in this particular connection, we may say that he certainly inherited a *whale* of a New England conscience. Not that he was finical. He was a realist, and some of his realism was unpretty. He was a man of the world, and he applied to the furtherance of his public and universal ends a deal of hard-headed worldly wisdom. Sometimes, in fact, a little less worldly wisdom and a little more divine would have better served his cause. Nevertheless, conscience and duty assumed in him the rigors of an old-fashioned Down East winter, and we can largely trace to the Stern Daughter of the Voice of God the development in him of the executive qualities he added to his engineering qualities. When facts are discovered, they usually indicate that something ought to be done. In the Taylor lexicon, *ought* was invariably followed by *can* and *will*. So he could not be content just with discovering facts. Do not these facts clearly point to this thing? *Then we will bring this thing to pass.*

Now, conscience implies a consciousness of what is due others, or what has come to be called social consciousness. This Taylor had in such degree that, to all appearances, it perfectly balanced his passion for investigation. We believe, in fact, that his life's *leitmotif* is to be interpreted in terms of the counterplay in him of these two forces; the one impelling him to discover and invent, the other to make his discoveries and inventions serve the interests of society. And as we follow him through his life, we perchance may catch the echoes of a noble, if largely unconscious, self-sacrifice born of this counterplay of forces. On the one hand, he longed for the peace and quiet of laboratory and study and the happy companionship of congenial souls; on the other hand, he was impelled to go out and fight to bring things to pass, so that his innately gentle spirit got all scarred up.

It has been said that his mother had the stronger personality, and that it apparently was through her that he acquired most of his characteristics. At the same time, we should be able to see in him a great deal of his father; and perhaps the respective qualities of his parents may help to explain the contradictory tendencies he occasionally exhibited.

Born in 1822 in Bucks county, Pennsylvania, Franklin Taylor was graduated in 1840 from Princeton University, receiving later from that university his degree of M.A. Immediately upon his graduation he settled in Philadelphia and studied law there in the office of a Mr. Peter McCall. Upon being admitted to the bar in 1844, he opened an office in Independence Square.

After the death of his wife, Isaac Winslow had come to Philadelphia to live, and so it was that his daughter Emily and Franklin Taylor met. They were married, so the family record states, "on Thursday, June 19, 1851, at 8 A.M., by

Friends' Ceremony, in the presence of Charles Gilpin, Mayor of Philadelphia, at the home of Benjamin Jones, with many of the Taylor and Newbold families present." But though they were married by Friends' ceremony, the ceremony, in that it was not performed in meeting, was "disorderly" from the Quaker point of view; and under date of October 16, 1851, we find this entry in Franklin Taylor's journal:

> Hester Ellis and —— Hutchins, two of the female overseers, called on Emily in the afternoon to see her about her disorderly marriage. They stayed about an hour, during which I came in, and we talked the matter over very calmly. Emily evinced no desire to remain a member, and when they left they inquired her middle name, which looks like a dismissal. The friends of Orange street meeting are very strict, and she undoubtedly will be read out.

And so it happened the following December. To all who knew her it will be evident how much there was behind that simple statement of her husband's, "Emily evinced no desire to remain a member." She had been married in a way she had chosen as meet and proper and suitable to her; and while she was quite willing to talk it over calmly, there it was.

The youngest of eleven children, Franklin Taylor apparently came into the world with spirit overtrained for life's battle. Most of his life he suffered from dyspepsia, and in consequence was often, in a mild way, irritable. He had little enthusiasm, and was devoid of aggressiveness and combativeness. At the best his practice of law was confined to routine office work, and it was not long before it became wholly perfunctory. His intellectual interests centred in history and languages, and of these he was a lifelong student. He had good business ability, was methodical, painstaking, and sagacious, but all his instincts were conservative. It was said of him, with exaggerated truth, that he never made any money or lost any.

Of old it has been recognized that, even as every developed woman has in her nature somewhat of those traits considered to be peculiarly masculine, so every developed man, every gentleman, has in him something of the feminine. Franklin Taylor was a gentleman. His journal, covering the period of his courtship of her who inspired in him a devotion that never wavered during their half a century of life together, reveals in him a delicacy almost painful. Time and again he was driven to clothe his thoughts in French, the genius of which so well adapts it to the expression of refinements of emotion and of scruple.

Yet for all the sensitiveness and delicacy that made him shrink from any rough contact with the world, his was a life of service. If he soon ceased to practice law for money, his legal knowledge and business acumen always were at the disposal of relative and friend. For no less than fifty-seven years he served as secretary to the Board of Managers of the Pennsylvania Training School for Feebleminded Children. He was a good neighbor; his time, his horses and carriages, anything he had, were offered to any who might need them, and offered in such a way as to make acceptance easy. He served all whom he knew how to serve. He might irritably turn away the beggar who came to his door; but then he would stand and wonder if he ought not to hitch up, overtake the beggar, and find out what really was the matter with him.

He keenly felt things, and felt keenly about things. While he had strong antipathies and prejudices, the proverbial Taylor loyalty suffered nothing in reputation from him. He was as loyal to his standards and principles as he was to any person he felt had a claim on him. He abominated any obtrusion of the ego such as the turning of a conversation into an autobiographic monologue, and abominated particularly the delusion that one's valetudinarianism is a thing of general interest. If he suffered much from dyspepsia, that was something of which one did not speak.

Attaining to the ripe age of eighty-eight, he long outlived all the rest of his generation. The older he grew, the more his nature mellowed and the gentler he became. His relations with his children always were engagingly simple and affectionate. His name for his younger son Frederick was "Bub"; and though he lived to see this self-reliant, masterful son reach the mature age of fifty-four, this son remained "Bub" to him to the end.

Death overtook him while he was with his daughter, Mrs. Clarence M. Clark, at her summer home at Manchester, Vermont. How he met his end was described in a letter written at the time by his son Frederick, and as there is no better way to tell what a man was in life than to see what he was in death, we here quote from this letter:

Father's best qualities [wrote Frederick Taylor in 1910] were never more conspicuous than when his last illness began. In spite of his soft, mild manner and a gentleness which was almost that of a woman, we who have been with him since childhood knew that he was a man of very unusual bravery and strength.

He was sitting near the first tee of the golf course, after his three grandsons had started to play in one of the competitions, when his right side was paralyzed. His mind, however, was not in any way affected. He carefully arranged his right hand and leg so that no one would know that anything had happened, and waited in his chair for an hour and a half, until one of the boys finished his round. In the meantime a number of people came up and spoke to him, and he shook hands with his left hand, and talked as unconcernedly as though nothing had happened.

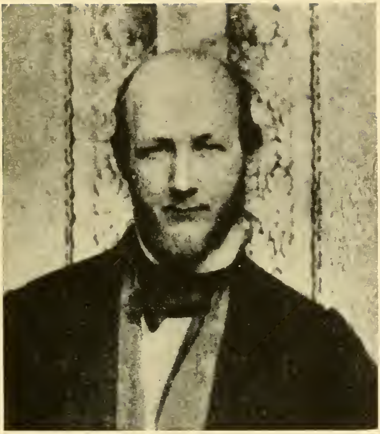
When Edward [his oldest grandson] passed by him on the way to the last green, father called him over, asked him first what kind of a score he was making, and told him to finish out his game and then come back to him. When he came back, he told him that he was paralyzed on his right side, and his manner was so absolutely simple that it took Edward some time to realize what had happened.

When he arrived at the house, and Mary [his daughter, Mrs. Clark] sat down beside him in the automobile, he smiled at her in his usual way, and said, "Well, Mary, I am all in. This is the last of me." He realized fully the seriousness of this kind of attack, because my mother went in exactly the same way. Throughout his illness he maintained the same cheerfulness and courage.

Two years after their marriage, or in 1853, Franklin and Emily Taylor permanently settled in Germantown, which, founded in the 1680's by the German liberals brought to this country by Penn's missionary journeys, adjoins Philadelphia on the northwest. In 1854 Germantown was annexed to Philadelphia, and now forms, with its outlying sections, Mt. Airy and Chestnut Hill, Philadelphia's twenty-second ward. To a large extent, however, it still remains in spirit an independent community.

Early in its history its German population was submerged by English settlers, and it still remains typically English in its social ideals and particularly in its devotion to outdoor sports. To say nothing of polo, here is one of the few places in the United States where the English game of cricket has flourished. It seems also, at least as regards its older part, quite a New Englandish place, so to speak. To this day, in fact, you can have the experience there of being received with stately decorum by ladies whose black silk evening gowns chastely blend with their immaculate, formal parlors, where the articles of adornment, free from frippery and separated by wide spaces, are yet sugggestive of those rich spoils of the sea that New Englanders used to bring home, even from far Cathay.

The devotion to English social ideals found in Germantown is, of course, that which pertains to the Philadelphia and Boston regions in general. If the weakness of New York always has been exclusiveness based on money, or rather on its expenditure, exclusiveness in Philadelphia and Boston has taken the less



FRANKLIN TAYLOR

EMILY WINSLOW TAYLOR

gross form of that which is based on family and the preservation of family traditions. Founded by a Dutch trading company, New York always has been predominantly commercial; in Philadelphia and Boston, on the other hand, the cultural influence of their religious founders has long abode. True, the old order in Philadelphia and Boston is now fast changing; but we may imagine that in those middle-nineteenth-century days when Franklin and Emily Taylor began their married life, it was in its full vigor.

Their first home in Germantown was a modest, severely plain two-story stone structure, with attic and wings, situated in what was then Willow Avenue and now is Morton Street. This house still stands. But whereas its neighborhood now is mostly given over to the homes of working people, it then looked out upon fields and streams, a mill-race, and clumps of woods. And it was here that the two sons of Franklin and Emily Taylor were born; Edward Winslow in 1854, and Frederick Winslow in 1856.

Even more rural was the section of Germantown to which his parents moved when Frederick Taylor was not yet a year old. The Willow Avenue home of the Taylors was to the east of what was originally Main Street and now is Germantown Avenue; their new home, "Cedron," in Indian Queen Lane, was far to the west of old Main Street in what was then practically all open country. It was at "Cedron" that Mary Newbold Taylor (Mrs. Clarence M. Clark), the third and last child of Franklin and Emily Taylor, was born, and the family continued to live here for twelve years, or until 1869. These were the years in which the long-smouldering, inevitable conflict between North and South burst into flame. Franklin Taylor was as much of an abolitionist as his wife, and both gave freely of their time and money to the cause.

Four years after the war ended they went to Europe for three years, mainly for the educational advantages that travel abroad would give their children. Upon their return to Germantown in 1872, they again settled in that more built-up section to the east of old Main Street. This their third and final home was a stone house of the near-Mansard-roof type that was so frequently built in this country in the 1870's; with grounds ample for gardens, lawns, and tennis court, it was, and is, situated just off Church Lane in what was then Ross Street and now is Magnolia Avenue.

That the family again went to live on the east side is to be explained mainly by Emily Taylor's desire to be near a highly esteemed friend of hers named Mrs. Isaac Pugh. As Sarah Pugh, this lady was known far beyond the limits of Germantown for her intellectual attainments, her forceful character, her high spirit; so that she had the distinction of being celebrated in verse. She had, too, as an old friend of hers still living in Germantown has expressed it, "a pronounced taste for lions." She established at her home something of a *salon* for those devoted to plain living and high thinking, and was indefatigable in capturing for it those distinguished as innovators and reformers. Here often came Lucretia Mott, and even such travelers from afar as those accomplished transcendental philosophers and leaders of English Unitarianism, James Martineau and his sister Harriet.

Surely in those days Germantown was in all respects a vivid bit of essential New England. It, too, from the beginning, was a place of sects, and here also reigned, throughout the eighteenth and early nineteenth centuries, a practically continuous religious, social, and political debate. From 1878 to 1882, the minister of the local Unitarian Church was that distinguished son of New England, Samuel Longfellow, younger brother of the even more distinguished Henry Wadsworth, and himself a man of high poetical inspiration, as is evidenced by his many hymns. Still another distinguished New Englander who served as minister of the Unitarian Church in

Germantown was Charles Gordon Ames. Apparently this church was a centre for the community's intellectual life. Frequently the widely-beloved Dr. William H. Furness came out from Philadelphia to fill its pulpit.

With this church Emily Taylor became identified as a regular attendant. Her husband, on the other hand, while retaining his membership in the Friends' Meeting in the town of his boyhood, ceased to attend any church.

In the main, Franklin Taylor enjoyed poetry, while his wife, in the main, did not. Apart from this, they had in common a love of literary study. Both were particularly interested in history and languages. He was the closer student of history, and she the more accomplished linguist. Her knowledge of French, German, and Italian was masterly, and she had a working knowledge of Spanish. Frequently she would entertain the ladies of her literary circle with such feats as off-hand translations from Italian into German.

It will be observed that her interest in languages was confined to the living ones. Among Frederick Taylor's papers was found an essay on "The Study of the Classics," evidently written by him when a schoolboy; and as it bespeaks the drilling he received from his mother, we quote from it:

> In practical life a knowledge of the classics is of almost no benefit to any but professional men, so that for most students of the dead languages the only good to be derived from them is the training which they give the mind. . . . But when there are so many other studies, which are an equally good training for the mind, and which would be of use to us in our business and our professions in after life I do not think that time is well spent in studying Latin and Greek.
>
> The faculty of the mind most benefited by the classics is the memory, while the powers of reasoning are but little improved by them. . . . The study of Latin and Greek gives us great command of language it is true, but the study of French and German does the same and besides a knowledge of these languages is of use to us in

every kind of business and gives those who are fond of reading much more pleasure than a knowledge of the dead languages.

Many say that the study of the classics is the only means of learning the grammar and construction of our own language. It may be so, but knowledge so obtained is merely theoretical, as many good Latin and Greek scholars speak bad English. A much more practical knowledge of grammar can be obtained by associating with those who speak good English, or by reading the works of our standard authors.

From the time they first were able to lisp, Emily Taylor tirelessly presided over her children's education. It was not so much that it gave her pleasure as it was with her a matter of conscience and duty. She was not a demonstrative woman. The English ideal of keeping all one's emotions properly and decently suppressed had in her an excellent exponent. It may be, as the poet says, sweet to dance to violins when love and life are fair, and to dance to flutes and to dance to lutes may be delicate and rare; but the tune to which life went for Emily Taylor mainly was sounded by the Spartan notes of the fife. Eloquent indeed of Laconia, of New England, of Puritan and Quaker ideals, was her system of child-training. It was work, and drill, and discipline. And child was remorselessly pitted against child. If the spelling bees she organized among her own children and such others who might happen to be present caused one or more of the children to be put to open shame, that made no difference.

She was particularly concerned for her boys. She was so anxious about them that some people thought it robbed her of the joy of motherhood. She was anxious that her boys grow up pure in mind and body. When the family was in France, and these boys then were being drilled in French particularly, she conscientiously went over in advance every book they were to read, and carefully pinned together such pages as she considered unfit for their young eyes.

She was particularly severe on anything resembling pride of the purse. She never set much store on tact. Tact she was inclined to associate with hypocrisy. She knew her mind, and in season she spoke it, plainly and to the point. Hers was the Quaker ideal of language stripped of all flattery and purged of all dross.

As for her household, it truly was a thing ruled, regular. When the family settled permanently in Ross Street, its menage included a cook, a waitress, and a coachman, all colored. Not only these servants, but also every other member of the household had his or her regular duties. To one member of the family was assigned the duty of seeing that all the match receptacles were kept filled; and when, after two years, the mistress of the household one day found a receptacle that had not been filled, the important thing with her was, not that all the receptacles had been kept filled for two years, but that on this day there had been a lapse.

Exacting she was, but also kindly and just. So Mary, the cook, Amanda, the waitress, and Thomas, the coachman, lived with the family for about thirty-five years. These colored folk were considered to be not merely in the family but of it. But let there be no doubt about this: if when her seamstress came to the house for a day's work, Emily Taylor insisted on her having luncheon with the family, and thus subjecting that working woman to not a little embarrassment, you could not possibly have persuaded Emily Taylor to pay her anything more than the current wage. Her son's principle of extraordinary pay for extraordinary work remained to her incomprehensible.

It was a household where the family life gathered about the evening lamp; the father reading, perhaps from some work of history in French or German, or from one of the standard writers of English fiction; the mother and the children listening; one boy, as he grew up, always doing his repectful best to listen, though his head might nod as he was gripped by fatigue from his ten hours' manual labor in a machine shop. It was a household in which there was realized the William Penn ideal of bountiful comfort. But it produced a boy who, scorning to sit on any cushion of advantage, resolutely asserted his right to conquer the world for himself.

CHAPTER III

THE BOY FRED

HE was an amiable, obedient, and vivacious child — the kind that uncles, aunts, and cousins like to have come for a visit. When he was only two, his parents readily could leave him at the home of a relative. To his mother's austere, rigorous drilling and training he, as long as he remained immature, responded with unswerving faithfulness. It is of high significance that he had a mother who believed in definite instructions, and that he was a son who readily could be trained to follow them. Significant also are the studies which Emily Taylor preferred for her children.

> The good classical scholars [wrote the boy Fred in the essay from which we previously quoted] are rarely as good at mathematics, to understand which requires one to be a good reasoner. Our most successful merchants and professional men are not generally those who have the longest memories but those who have been taught to think, therefore to be successful in life we should cultivate our thinking powers and not so much our memories.[1]

While the ideas in this schoolboy essay undoubtedly were those of Fred Taylor's mother, she could not have had much difficulty in persuading him to adopt them. It would not appear that any external pressure ever had to be applied to him to get him to use his brains. That, as soon as he began to think at all, he became enamored of scientific investigation, research, and experiment; that from the beginning he had a passion for improving and reforming things on a basis of fact, and early

[1] Whatever may be the explanation, the fact is that Taylor's memory throughout his life was indifferent at the best and usually was poor.

was filled with a divine discontent with anything short of the *one best way;* that he was born with the high moral courage to seek and follow the one best way regardless of how it might appear to others — to these things there is testimony in plenty. In fine, he apparently came into the world, not only with Puritanism's bold spirit of inquiry wrought into the texture of his being and with all of the Puritan's passion for making the new vision, the one best way, *prevail,* but also with an intense infusion of the ultra-modern spirit in its demand for verification.

The following was written us by Birge Harrison, the artist, who lived with his parents near "Cedron" in Indian Queen Lane, and who, a playmate of the Taylor children, became a lifelong friend of Fred:

With our brothers and our boyhood friends we led a healthy, normal life in the woods and fields about Germantown, playing cricket and rounders, football and mumble-the-peg, and scouring the countryside for thirty miles about in search of minerals and "specimens" of various kinds — for under Fred's leadership we were all more or less "scientific," even founding the "Germantown Scientific Society" whose oldest charter member, if I remember rightly, had not reached the age of fifteen.

Fred was always a bit of a crank in the opinion of our boyhood band, and we were inclined to rebel sometimes from the strict rules and exact formulas to which he insisted that all our games must be subjected. To the future artist, for example, it did not seem absolutely necessary that the rectangle of our rounders' court should be scientifically accurate, and that the whole of a fine sunny morning should be wasted in measuring it off by feet and inches.

It seemed to some of us also that Fred was a trifle over-severe in his insistence upon the strictest possible observance of all the rules of the game — whatever it might be that we happened to be playing. But once this observance of the law was conceded and agreed to he was most generous to his opponent, allowing him every possible chance to win and conceding every doubtful point. And indeed it always seemed to me that the combination of these two qualities, which were so remarkably apparent in the boy — generosity, and a strict and uncompromising demand for and adherence to the truth and the law, had much to do with the success of the *man* in the development of his system of scientific management.

Even a game of croquet was a source of study and careful analysis with Fred, who worked out carefully the angles of the various strokes, the force of impact and the advantages and disadvantages of the understroke, the overstroke, etc. It was inevitable, of course, that his passion for invention should have been very early developed, and on our cross-country tramps he was constantly experimenting with his legs in an endeavor to discover the step which would cover the greatest distance with the least expenditure of energy; or the easiest method of vaulting a fence, the right length and proportions of a walking staff, etc.

No matter what the form of activity, he sought to improve it. On Germantown's many hills there was fine coasting, and great was the rivalry between bob-sleds from the east and west sides. All the other boys were content to stop their bobs by digging their feet into the snow; but Fred Taylor must needs devise a brake in the nature of a long-toothed rake. Bean-bag, originally a health exercise, often was played by the young people of Germantown. The game was for the boys and girls to stand facing one another in two lines, each of which represented a team; then from the head of each line a bean-bag was passed along to the foot and back again; each line, of course, striving to get its bag back first. It appeared to sixteen-year-old Fred that in this game the players stood idle too much of the time — did not get enough exercise. So he gingered things up by giving each side two bags, and having these bags started in the middle of the line towards each end, and so passed back again to the middle.

The most remarkable invention of Taylor's boyhood is decribed by Birge Harrison as follows:

I remember very vividly one invention which he made at about the age of twelve. At that time his sleep was not of the best and he was troubled with very fearsome and terrifying nightmares. Being of an observing nature, he soon noticed that when he awoke from one of these obsessions he was invariably lying on his back — and from this he argued that there must be some connection between the position in which he lay and the distressing mental disturbance. Thereupon he constructed for himself a sort of harness of straps and wooden points, the latter so arranged that whenever in his sleep he turned over on his back the points in question would press the dorsal muscle and at once awaken him. I think it was the Spartan nature of the contrivance which impressed me at the time, and for that matter still impresses me. But the thing worked and Fred ceased to be the victim of his unquiet dreams.

Previous to contriving this harness of straps and wooden points, he had tried many other things, all of a Spartan nature, in his effort to get rid of his terrifying dreams. He had tried sleeping on corn-husks and sleeping on the hard floor. Then, on the theory that the thing to do was to keep his brain cool, he had experimented with a pillow of tufted haircloth, and also with a pillow consisting of a board with uprights at each end over which was stretched a piece of canvas. On each side of this latter pillow was a peg by which it could be tilted at various angles. He even tried stretching strings across the uprights, and would wake up in the morning with the marks of the strings covering his face.

Though the harness of straps and wooden points was his most successful nightmare-fighting device — he continued to use a modification of it while he was at Phillips Exeter preparing for college — Mr. Harrison was mistaken in writing that it was a complete cure. It was an easy mistake to make, since it was as deeply inbred in Frederick Taylor as it was in his father to regard any physical infirmity as a thing of little interest to one's friends. The fact is that he continued to suffer from insomnia throughout his life, and might often have cried out to God as did Job: " When I say my bed shall comfort me, my couch shall ease my complaint, then thou scarest me with dreams, and terrifiest me through visions." After he had discarded his harness, he adopted the expedient of sleeping propped up with pillows in a bolt-upright sitting posture, and this he continued during the rest of his life; so that when he went to a hotel there always was a struggle to get enough pillows for him, and often he was compelled to eke out the pillows with drawers pulled out from a bureau.

Though it disappoint all the Freudians, we are unable to give any details of his dreams. Dr. Judson Daland, who was his physician, attributes them to his extraordinarily intense nature. But how can anyone, even a Freudian, plumb the depths of those solitudes from which a man's nature arises? Surely we have only to study one another's faces to have it impressed upon us that in each are inaccessible solitudes where, due to man's age-long struggle to rise from the clod, lies tragedy piled on tragedy. And surely those visions of Frederick Taylor's are strangely reminiscent of his forefathers, who, in the words of Carlyle and Macaulay, grappled like giants " face to face, heart to heart, with the naked truth of things "; who were " half-maddened by glorious or terrible visions"; who " heard the lyres of angels or the tempting whispers of fiends"; " who caught glimpses of the Beatific Vision, or woke screaming from dreams of everlasting fire." There is evidence that, haunting some part of the nature of this courageous man, was the ghost of a fear, a horror. His friends had intimations of this when they would speak to him of illness and death. Though he would remain silent, they would become conscious that he was suffering, and their utterance would be checked.

A thing which seems certain is that Frederick Taylor's subconscious mind received no morbid suggestions from his conscious. When we examine the journal he kept at the ages of thirteen and fourteen, or during two of the three years his parents had him abroad, we find it speaks in every line of a boy not at all given to introspection, but keenly and healthily interested in nature and in all the life about him.

He was a studious youth. When he had a book in hand, you had to scream at him, as his sister said, to get his attention. But he was the exact opposite from a killjoy or spoilsport. Get him to realize there was something doing in the way of sport, and he was with you on the jump, particularly if the something doing was out of doors. You had him with you, not only when there was sport, but when there was mischief. He was one tease, and he spared but few. There was the slender, graceful, light-hearted girl whose parents, Dr. and Mrs. Edward A. Spooner, were the friends of his parents, and who often came out from Philadelphia to visit the Taylor household and get the benefit of its country life. It was she who was destined to inspire in Frederick Taylor a lifelong devotion; but when one day he was left alone with a vase of flowers belonging to her he could not resist the temptation to slip into the water something that completely changed the color of the flowers; and when this young girl came back to exclaim, "Why, these are not my flowers!" he thought it was a great joke.

In Germantown lived two shrewish maiden ladies; and it is said that Fred Taylor led raids on their cherry trees, not because he wanted the cherries, but for the unholy joy of getting the ladies to come out and scold. If in the wisest and best of us there is some admixture of folly, you could rely on him to see the folly. In his later years he used to tell with glee how a lady at one of his mother's literary gatherings made the experiment of reading one of Browning's poems backwards, to find it went this way just as well as it did forwards; so that all the other ladies there assembled still cried, "How beautiful! how wonderful! how sublime!" Though doubtless highly apocryphal, the story may be taken as indicating that few were the things which escaped Fred Taylor's impious eye. That he had a keen sense of the admixture of folly in the abolitionist movement may be gathered from this incident in his testimony in 1914 before the Industrial Relations Commission:

Mr. Taylor. In my youth my mother was a very strong antislavery woman; she was a friend of Lucretia Mott, William Lloyd Garrison, and Charles Sumner, and when I was a little boy I lived with antislavery people, and when Lincoln's proclamation came out I remember distinctly, young as I was, and I remember a great many of these antislavery happenings and their disappointment because it abolished their society. [This stenographic report was uncorrected, and doubtless is imperfect.] And so with the [labor] union people; they are sorry because we are doing more for their men than they, and are sorry because we are treating them better and giving them shorter hours, and they feel sad that a man leaves the union for the same reason that these people felt bad because Lincoln issued his antislavery proclamation.

Commissioner Weinstock. Their occupation was gone?

Mr. Taylor. Yes, sir; I can not help being amused at that analogy. I remember it distinctly. I was only a young boy at the time; but these women had won their cause, and they felt darned sorry about it.

Among his boyhood's chums were Clarence M. Clark (who later married his sister) and Joseph Clark, sons of E. W. Clark, of the Philadelphia banking house of E. W. Clark and Company. The spacious grounds of the Clark residence in Germantown were surrounded by a stone wall; and on fine spring and summer evenings outlying sections of this wall often were used as perching places by loving couples composed of housemaids and the sons and daughters of the neighborhood's coachmen and gardeners. To the Clark place at dusk one evening came driving in a buggy Fred Taylor and another pal of his, Wilfred Lewis. Catching sight of the fine assemblage of lovers on the wall, Fred Taylor cried " Whoa! " and proceeded to lecture them with a flow of language that seemed exhaustless. Ought not those young women to be ashamed of themselves? — what were their mothers thinking about to let them out? And what sort of principles had those young men? As was often the case, you hardly could tell whether he was or wasn't in earnest; and to his chum sitting with him in the buggy it was amazing that not one of those husky youths on the wall showed any inclination to jump down and use his fists. He must be regarded, apparently, as a remarkable example of the power of a high spirit to surround one with a protecting charm.

Certainly he was, and remained, a past master in the art of what in chaste English is known as raillery, in polite slang as "spoofing," and in slang not so polite as "kidding." As a boy this propensity of his sometimes made him seem provocative, and it was his habit to be positive and disputatious. His old friends will tell you, however, that his nature was entirely free from the pugnacious. His raillery, of course, was for the most part just an expression of that superabundant flow of spirits which made him the life of any party he might attend. Still, it easily could run on into pure deviltry. No peculiarity or whim of yours could escape his hearing ear and seeing eye; give him an opening of this kind, and as they say on the ball field, he would " ride " you unmercifully. Though he could make his raillery so subtle as to be hardly perceptible, he would freely display his gift for biting sarcasm when exasperated, as he easily could be, by stupidity, slackness, conceit, cant, affectation, or sham. He loved to shock the shockable, and to amuse himself with cynical expressions. There was much in him of the grim and dour Puritan. Yet he also had his father's sensitiveness, delicacy, gentleness, and sweetness, and if the cases were few where anyone took offense at

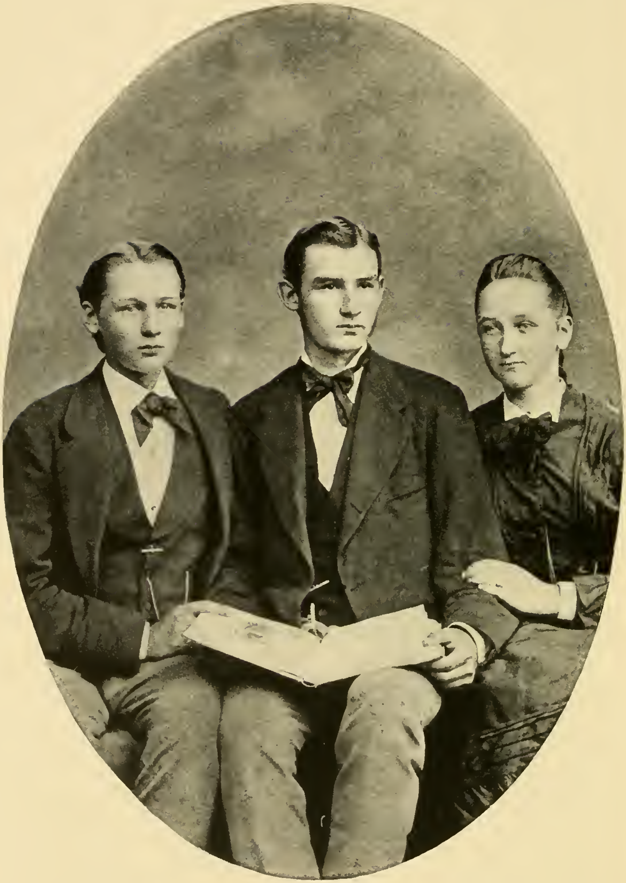
FREDERICK W. TAYLOR

Age 2 years, 7 months

Age 11 years, 5 months

Age about 14

Age about 17



"FRED" TAYLOR (*left*) AND HIS BROTHER AND SISTER
Age about 18

anything he said or did, it was due, not merely to the height of his spirit, but its entire freedom from malice.[1]

The journal he kept during two of the three years he was in Europe with his parents and brother and sister pictures a boy not only healthily interested in the life external to himself, but also loyally responding, largely at the sacrifice of his own inclinations, to the rigorous educational régime prescribed by his mother. Evidently Emily Taylor was bent on giving her children a polite as well as a practical education, or on having them cultured according to what people in her station regarded as the best standards. In this ambition she was not greatly different from most persons of Quaker training at that time; even before the 1860's Quakerism as a body had begun to abandon its peculiarities of dress and language, and the Quakers who continued to discourage the cultivation of the arts probably were the exception.

Mainly she took advantage of their stay abroad to have her children drilled in French and German. To help with the German, a governess was employed while the family was in Berlin. "For many years," Frederick Taylor wrote in 1910, "I spoke both French and German about as readily as English; and on returning to France last year found myself able to speak French in about ten days nearly as fluently as ever."

In Berlin, the thirteen-year-old boy also was required to spend two hours a day in piano practice, and with the other children was taken regularly to concerts and the theatre, to all the places of historic interest, to museums and art galleries. It was not just attending and listening, not just visiting and looking things over; it was study, it was work. And in the evening the father read aloud, usually from some book that would help the children understand what they had heard or

[1] Those who knew Taylor the best are wont to complain that his photographs commonly make him look too serious. The look which abides with many of his intimates is such as he would give over his spectacles — a quizzical, mischievous, impish look.

seen that day. It is hard to believe that ever were there more conscientious parents than Franklin and Emily Taylor. It was a family in which conscience and duty were exalted to the nth degree.

In Fred Taylor's journal we find dutifully set forth minute descriptions of what each day he heard and saw. There are detailed descriptions of pictures particularly. Evidently his parents had more real interest in the graphic arts than in such an art as that of music, for he speaks of them attending a performance of " Faust " and not enjoying it. Even while he was being drilled linguistically and in history and art, his regular lessons went on abroad, at school and at boarding place. He writes with real enthusiasm of his wrestlings with problems in geometry and in other branches of mathematics. His journal is also replete with the interests of a regular boy. He collected postage stamps, too; but what at this time evidently lay closest to his young heart was his collection of birds' eggs; apparently wherever the family went in Europe he haunted the stores that sold such eggs, and devoted most of his pocket money to their purchase. We can well believe that the transportation of these fragile articles imposed on the family some serious problems; but the collection, unusually extensive for a boy's, was safely brought to America, and still is intact. That he carried his mischievous spirit to Europe will appear from the entry in his journal in which he describes a visit in Berlin to " Monbijou Pallace," where among other things on exhibition were relics of Frederick the Great. " Frederick," writes his young American namesake, " seemed to have made a collection of fluits and other musical instruments. I played Yankee dudle on his piano."

It will be seen that at thirteen his spelling was boyish to a degree. Better train the reason than the memory, you know. However, there comes in the journal a sudden and marked improvement in spelling; apparently Master Fred got jacked up about this weakness of his in a way that impressed him. He has all of the normal boy's interest in girls. He writes of a girl with whom his brother and another boy fell in love, but she was not pretty enough for him. Then there is a reference to a girl who called on "sis," and was "unusually good looking for a german." Apparently the family's experiences with the good Berliners were not altogether happy. Here is this delicious bit from Master Fred's journal:

> Went to a beer garden where Mrs. ——— [a German lady] had a sossage some of which she would tak with her knife and lick it off then with the same knife cut off a slice and offer it to the rest of us Not many of whom took any of it. When she presented it to mother there was quite a crook perceptable in her nose which is mothers sighn of disgust.

His own boyish experiences with the Germans were far from happy. This is brought out in a letter he wrote forty-five years later. In 1913 there came to him at his Chestnut Hill home two Germans who, representing themselves to be engineers interested in Scientific Managment, asked him to give them a letter to the president of a New Jersey cotton mill that had installed his system. This he courteously did. Several months later the president of the mill discovered that these two men were employed by large spinning and weaving plants in Germany, which plants now were circularizing all the New Jersey mill's customers and otherwise were making systematic efforts to steal these customers away. Upon receiving the letter giving him this intelligence, Taylor, under date of January 21, 1914, wrote to the president of the New Jersey mill as follows:

> I am exceedingly chagrined to hear, from yours of Jan. 20th, that in Mr. ——— and Dr. ——— I sent two traitors into your camp. This incident again confirms my profound distrust of Germans. Since

spending a year and a half in Germany as a boy I have disliked them exceedingly; in fact, have never gone back to Germany since that time. I can assure you that I will be mighty careful about again giving a letter of recommendation to a German. I feel very much ashamed of this incident.

It will be observed that this letter was written just six months before the Germans amazed most of us by their sudden leap upon Belgium and France. Several times in his later years Taylor journeyed to England, France, and Italy, but nothing could induce him again to set foot in Germany. The trouble mainly was that the German boys with whom he tried to play games outraged his sense of sportsmanship. He found, so he told his friends, that Germans were unfitted for participating in any game depending upon the personal honor of the player. The idea that defeat was greatly to be preferred to winning through any violation of the rules was to them incomprehensible. They would lie and cheat without compunction in order to win, and would whine when they were beaten. Throughout his life Taylor was in the habit of saying in his sweeping, enthusiastic way, "All Germans are liars." Of course he did not mean to have this indictment by him of an entire people taken too seriously. A man of his temperament could not help but admire the general thoroughness of German methods, and some of his good friends among workmen were Germans. Nevertheless, his dislike and distrust of Germans as a race was as profound as it was lasting.

After their first winter in Berlin, Franklin and Emily Taylor traveled with their children through southern Germany and on into Austria and Italy, and back into Switzerland, where the boys took full advantage of the opportunity to indulge in mountain climbing; Fred, as usual, experimenting with various methods of using his legs and with all kinds of devices for assisting them. The winter of 1869–70 the family spent in Paris, where the children went to school. In the following spring, parents and children again went traveling; this time through Belgium, Holland, England, Norway, and Sweden. On July 16, 1870, they arrived at Copenhagen, Denmark, by steamer from Sweden; and under this date we find this entry in Fred's journal: "On arriving we learned that war had been declared between France and Prussia. We boys go for France and the others for Prussia." Always Taylor was deeply in sympathy with France; so that it was most grateful to him that the French, of all peoples, seemed to take the most readily to his system of management. Doubtless in July, 1870, his boyish sympathy for the French cause was assisted by the aversion he took to a German teacher he had in Paris the previous winter. Of this man he wrote in his journal:

> When I first saw him I thought him a very pleasant man but I was not there over a week when I commenced to see his real character. He treats his wife very badly and even makes her cry before all the boys at table. He is all laugh when one first sees him but afterwards he proves himself a thorough German. [Note the improvement in spelling.]

In 1870 his parents took him back into Germany, and there his journal suddenly collapsed, never again to be resumed. No form of autobiography could appeal for long to Frederick Taylor. The nearest approach to it in which he ever again indulged was a letter of about 2,000 words he was persuaded to write by his friend, Morris L. Cooke, when, in 1910, various magazines began to take interest in him on account of the sudden general publicity given that year to Scientific Management. This letter began as follows:

> In answer to your letter asking for facts in my personal history, I can hardly think of any with which you are not already familiar.
>
> The two years of school in France and Germany, and then a year and a half of travel in Italy, Switzerland, Norway, England, France,

Germany, Austria, etc. (of all of which I disapprove for a young boy), then a return to the healthy out of door life of Germantown, than which I believe there is nothing finer in the world, in which sport is the leading idea, with education a long way back, second. Then two years of really very hard study, coupled with athletics, at Exeter, and what I look back upon as perhaps the very best experience of my early life, namely, the very severe Exeter discipline, in which no excuse was taken for any delinquency whatever, and in which every boy had to toe the mark in all respects.

Though he came to disapprove of most of the education he received as a boy, and wrote enthusiastically of the training he received at Exeter, he was of the opinion that even that training had its "wrong side." However, we shall see that it was the "wrong side" which led to the experience that revolutionized his outlook on life and determined his whole future career.

CHAPTER IV

HOW HE DID NOT BECOME A LAWYER

PREVIOUS to his being taken to Europe, he had attended the Germantown Academy. He and his brother, however, were sent to Phillips Exeter, at Exeter, New Hampshire, almost as soon as the family returned from Europe in 1872, to settle in Ross Street. The official records show that Frederick Winslow Taylor registered at Exeter on September 4, 1872, as a student in the middle class, to prepare for Harvard College. It was his parents' plan to have his brother become a physician, and him a lawyer.

At Exeter he roomed and boarded at the home of a Mrs. Cilley with his brother, his cousin, James A. Wright, Jr., and three other students. After his first year, James A. Tufts, now a professor at Exeter, became his room-mate at Mrs. Cilley's. Professor Tufts tells us that "the house was colonial in style, large and homelike, and the family interesting." Fred Taylor had a great time there teasing his hostess's daughters. The circumstance that this family had ideas of the strictest New England type as to what was proper in social and religious observance gave him a fine opportunity in his capacity of shocker extraordinary. He loved to make his hostess and her daughters gasp by arguing that there was nothing wrong in playing games on Sunday.

The fact that in his "prep" school days he enjoyed attacking religious ideas that most people regarded as vital may well bring up the question as to what were his own ideas in this connection both in youth and maturity.

Among his effects was found a bit of paper on which was written in his own hand, apparently at an early age, a verse which, under the heading "Good Creed," reads as follows:

Man comes into this world naked and bare.
He passes through this world with trouble and care.
His exit from this world is I know not where.
But if he does well here he will do well there, and I can tell you no more if I preached a whole year.

Whether he got this doggerel from someone else or himself perpetrated it, it may be taken as reflecting his attitude towards religion throughout his life. Though wont to group theologians with politicians and Germans as eminently eligible for membership in an Ananias Club, he came to discriminate more and more between that religion which is purely formal, or merely ecclesiastical, or simply a matter of hearsay and cant, and that religion which is the sincere expression of the feelings of one's heart. If he continued to heap scorn on the former kind, no one, as he matured, could have been more respectful of the latter kind. At all times, however, his attitude towards "revealed religion" was frankly agnostic in the true sense; that is, he did not necessarily deny, but he did question.

That, to some extent, he always identified himself with the church his mother came to attend, is indicated by the fact that in his latter years he refused to give money to the Young Men's Christian Association as long as that organization discriminated in any way against Unitarians. But, after repeatedly trying it at various intervals continuing into his latter years, he had to give up regular attendance at any church. This is brought out in a letter written us by the Rev. Oscar B. Hawes, former minister of the Unitarian Church in Germantown:

Mr. Taylor spoke two or three times at the meetings of the Men's Club of the Unitarian Church at Germantown. In the Minutes of our Club I see there is a memorandum that Mr. J. M. Dodge and Mr. Frederick W. Taylor spoke at one of the very earliest meetings of the Club, held on November 3rd, 1902. Mr. Taylor always spoke with great force and most effectively on the subjects dealing with industrial conditions and the welfare of the working men. On two or three occasions he gave the "Address of the Evening" at our Club. On numerous other occasions he entered into the discussion which followed after the principal address. He was interested in the practical work of the Club, and during the early days of the formation of our Nicetown Club for boys and girls he was very helpful in giving suggestions as to instructions and methods, etc.

Mr. Taylor did not often attend church. I think he felt that he was doing practical religious work all the time. His mind was so keen that when he attended service he often wanted to "answer back" and felt the inadequacy of a service where but one point of view was expressed. I am told that he would occasionally take notes on his cuffs, but in regard to this I am not sure, nor am I certain as to the accuracy of my understanding in regard to his general attitude.

Despite Mr. Hawes' uncertainty as to these latter particulars, they are quite correct. It was the exact opposite of indifference that kept Mr. Taylor away from church.

Such was his demand for verification that he was distrustful of anything that was not based on definite, tangible, provable facts. He was the most courteous of conversationalists, he always let the other fellow have his say; but he simply could not sit quiet until you had got your facts straight. If, as George Eliot said, Herbert Spencer's idea of a tragedy was a theory killed by a fact, Frederick Taylor's idea of a tragedy was a fact killed by a theory.

He was indeed restive in church, taking notes on his cuffs, and all that. He felt he was there introduced to a region where there was nothing his mind could grip, nothing he could get hold of and keep hold of so that it could be used to trace out a law.

To him religion was something practical, or it was nothing. While, on select occasions when he could give vent to the mischief in him, he shocked even such liberal religionists as Unitarians by his seemingly irreverent denunciations of "all this come-to-Jesus business," he was delighted beyond measure when he heard a clergyman at the Labor Temple in New York City deliver an address to workmen that had reference to their every-day work in the shop. "God," said Charles Kingsley, "is eternally God because He is eternally useful." And that, as Frederick Taylor's friend, B. Preston Clark, tells us, apparently was Frederick Taylor's idea of a God exactly. Toward the close of his life, Mr. Clark argued to him that Scientific Management was the continuation and extension of the old religious truths of love and service. And we are informed that he nodded his head.

He was known at Exeter as a close student who never was satisfied with anything short of his best, and who got brilliant results mainly through hard work. In his second year he led his class. However, you could not call him a grind — there was too much fun and sport in him. He and James A. Tufts were on the same boat crew. He was a fine gymnast, and among the fanciest of fancy skaters. For a while he was captain of the baseball team. He did the pitching. In those days pitchers were supposed to deliver the ball underhand or from below the shoulder, but he must needs deliver the ball from above his shoulder, and in consequence had frequent wrangles with umpires.

Here, as at other places, he was celebrated for his impish ability to mimic the peculiarities of others. But, says Professor Tufts, "he was always cheerful, optimistic, genuine. He never uttered a foul or unkind word, never boasted, never shirked." He hated quarrels. At that time there was at Exeter something of the bad feeling between town and gown which used to make old Oxford such a lively place. Fred Taylor, however, led in bringing about peace.

The professor of mathematics at Exeter during his years there was a famous character named George A. Wentworth — "Bull" Wentworth, he commonly was called. One custom of Professor Wentworth's made upon Taylor an impression most profound. When he was being examined in 1912 by the Special House Committee, he was asked: "How is it possible to study how long the workman should take in that part of the work that is purely mental? For example, how long he should take in making up his mind how work should be done or in reading and grasping a drawing?"

The first piece of time study that I ever saw made by anyone [replied Taylor] was made in the study of just that thing, a study of the mental capacity of boys. When I was at Phillips Exeter Academy Mr. George A. Wentworth was the professor of mathematics, and he worked off his first geometry while it was in manuscript and his first algebra on my class, the class of '74. He worked those books off on us for the two years while I was there. I, as a student, wondered how it was possible (that right along steadily, right through from the beginning to the end of the year, as we went on from month to month) that old bull, Wentworth, as he was called, gave us a lesson which it always took me two hours to get. For the two years I was there I always had to spend two hours getting that lesson, and finally we got onto his method. We were very slow in getting onto it, however.

Mr. Wentworth would sit with his watch always hid behind a ledge on his desk, and while we knew it was there we did not know what the darn thing was used for. About once a week or sometimes twice a week he went through the same kind of exercise with the class. He would give out a series of problems and insisted that the first boy who had them done should raise his hand and snap his fingers. Then he would call his name. He went right through the class until just one-half of the class had held up their hands. We always noted when he got half way through the class and the middle boy would snap his fingers he would say, "That is enough; that will do." What he wanted was to find out just how many minutes it took the average boy in the class to do the example which he gave. Then we found that Wentworth timed himself when he first tackled those problems. He got his own time for doing those five examples, and the ratio between his time for doing the examples and the time of the middle boy of the class enabled him to fix the exact stunt for us right along. The speed of the class changed. He did not change. All he had to do was to get this ratio of change, and he could say, for instance, the average of that class will take two hours if I can do the example in 25 minutes, and in this way he was able to give the class its proper stunt right along. That was the first instance of a time study of mental operations which I had ever seen.

In writing in 1910 about "the very severe Exeter discipline," Taylor added: "At that time one-half of the scholars at Exeter were dropped each year." It was indeed a case of toe the mark and no excuses. No cuts were permitted. Every student had to appear at chapel. After expressing his approval of all this severity in general Taylor continued:

> It was the wrong side of the Exeter training, however, which ruined my eyes and left me no alternative than working as a workman for the four years following 1874. At that time the great ambition of all boys at Exeter was to be the head of the class in studies, and the competition was so severe that all of those who were not very brilliant had to work away late into the night in order to get there. It was this competition that broke my eyes down, and it should be also noted that three other men who led the class before I did also broke down and had to leave Exeter on account of poor health.

Writing in 1912 to a friend, Taylor, referring to one of his adopted sons, said:

> I finally decided to send him to Milton Academy this fall. Should have preferred Exeter, but there is no restriction whatever at Exeter on the hours in which the boys can study, and I thought it would be better for Robert to be where he was obliged to have lights out at ten o'clock.

Professor Tufts, speaking of Fred Taylor's eye trouble, says: "He feared he might not be able to go to college, but he resolved to complete his preparation and he passed the Harvard examinations in June, 1874, with 'honors.'"

We are told that his eye trouble could, with the advance in optical science made since then, be now readily corrected. As it was, his eyes had to have a long rest from reading. And so it was that, while his brother went on to college and became a physician, Frederick W. Taylor did not become a lawyer.

If he returned to his parents' home to rest his eyes, it was the only form of rest he did get — we might say *could* get, imbued as he seemingly was with all of the seventeenth-century Puritan's deep sincerity and flaming zeal. Even when he sought relaxation in sport, that same terribly earnest spirit took possession of him, and sport became for him almost as nerve-draining as work. Which leads us on to say that, whatever his faults, they were not of a kind to create for his biographer any problems in discretion. His whole life really was an open book. It is not on the record that he ever did anything common or mean. There was nothing little about him. Practically all of his faults, in fact, had their origin in that intense earnestness and zeal of his, he being inclined to overdo in everything. A man, of course, may resist his inclination, and Taylor was not without success in holding himself in — far from it. Acting as brakes on his tendency to go to extremes were his strong instinct for the practical, with its underlying quality of common sense, and his equally strong instinct for the social, with its underlying quality of amiability. Nevertheless, he always was likely to exhibit a certain too-muchness. He suffered markedly from the excess of his virtues.

Eventually he himself became fully aware of this fault of his. Despite his proud habit of keeping his troubles to himself, now and again, in his correspondence with his friends in his later years, there was sounded a note of unconscious pathos as he referred to the merciless way he had driven himself in his youth, and thus had permanently weakened his ability to endure. He was anxious that all young men avoid the mistake he made of thinking he was made of iron. But even after he became fully aware of his tendency to overdo, he could not spare himself. He became like Kipling's explorer. There was at him a voice "as bad as conscience, ringing interminable changes on one everlasting whisper day and night repeated — so: 'Something hidden. Go and find it.'" He must "go — go — go away from here." There always was some place at which he was overdue. Not geographical exploration, but exploration of the way things work. Not going and going in space, but in mind, in thought. For the places at which he was overdue were those facts that always lay ahead.

With eyes made useless for study, he was in despair upon his return from Exeter to Germantown. For a time it seemed like a tragedy to him, this temporary disability that was to direct his life into what we must regard as its true channel. As boy and man, all his forces centred in his head. He hated to do things with his hands. Though he always had been ready to help his mother with such odd jobs about the house as hanging pictures, it was not because he enjoyed it. But now, because he could not study and had to do something, he was avid even of such jobs as carrying stones for his mother's hotbeds. And as jobs like these became unable to absorb his energy, he, late in this year of 1874, when he was eighteen, seized upon the chance to learn, in the shop of a small Philadelphia pump-manufacturing company whose proprietors were acquainted with his family, the trades of the pattern-maker and the machinist.

CHAPTER V

HE ENTERS INDUSTRY

THIS Philadelphia concern in whose employ Fred Taylor learned his trades was known as the Enterprise Hydraulic Works, and the firm that owned it while he was there was first Ferrell & Jones and then Ferrell & Muckle. The works were situated in Race Street, down near the Schuylkill River.

In the lecture on "Success" that Taylor, upon his retirement from money-making business, delivered at various engineering schools, he told of an incident in his life at this time that he never forgot, though, as he also said, it took him many years to realize all it meant. We quote from the manuscript he used as a basis for this lecture:

When I was about to begin to serve my apprenticeship, an old gentleman who had been very successful sent for me to come to see him. He lived some 20 or 30 miles away, and said that he had something very important to tell me. What he had to say took but three or four sentences. He said: "If you want success in your work, do what I say. If your employer wants you to start work at 7 o'clock in the morning, always be there at ten minutes before seven. If he wants you to stay until 6 o'clock at night, always stay until ten minutes past six. Now, if you haven't sense enough to know what I mean by this, you haven't sense enough to succeed, anyway."

He also said: "Let me tell you one more thing. Whatever happens, however badly you may be treated, however much you may be abused, never give up your job until you have taken 48 hours to think it over; and if possible don't talk back to the man who is over you until you have time to cool off." [1]

[1] The "old gentleman" who gave young Taylor this advice was his uncle, Caleb N. Taylor, president of the Farmer's National Bank of Bristol, which

In 1876, when the international exhibition was held in Philadelphia to celebrate the centennial of this country's birth, Taylor was persuaded by his cousin, Edward I. H. Howell, to leave his apprenticeship for six months, and join in representing at the exhibition a group of New England manufacturers, chiefly of machine-tools. As there were many foreigners among the visitors, his cousin wished to take advantage of Taylor's knowledge of French and German. Now, Taylor's mature observation was that the great motive power of most successful men is "singleness and earnestness of purpose"; and it would appear that the value of this was impressed upon him in his apprenticeship days by an experience he had at the exhibition, which experience was related by him as follows:

One day an old gentleman came into my exhibit, and I saw at once by the questions which he asked that he was a fine mechanic. I took every pains to explain our machines and tried to sell him some. After a while he sat down and asked me to sit alongside of him. He said: "What is your idea for success in life?"

I said I didn't know, that I had no particular idea.

"Why," he said, "you must have something that you are working for."

I said: "Yes, sir, I am working to get to be a machinist and earn $2.50 a day."

"Oh, no," he said, "I don't mean that. When I was your age and before I was out of my apprenticeship, I had made up my mind just what I was going to do. I decided that I was going to learn how to do work just a little more accurately than any of the other apprentices around me, and when I had succeeded in doing this, then I decided that I would learn to do it still more accurately than I had done before. Throughout my whole life that has been my one idea. I have never cared so much about the rapidity of the work — although I worked about as fast as other people — but I have always

---

bank was founded by Anthony Taylor, the father of Caleb and of Franklin. Caleb Taylor was a very important man in his community; being, we are told, the first Republican ever elected to Congress from the district formed by Bucks and Montgomery counties.

been determined to do a little better work than anyone else around. That is what I am still aiming to do to-day, — to do better work next year than I am doing this year." He said: "I suppose you know who I am?"

"No."

"I am 'Old Man Sharpe,' at the head of the Brown & Sharpe Company of Providence, R. I."

Now, this simple idea has been enough to build up and keep through two generations the great Brown and Sharpe Company, at the head of all companies in this country who are doing accurate work, and probably no finer work, on the whole, is done in any company throughout the world.[1]

Starting in the latter part of 1874, Taylor finished his apprenticeship in the latter part of 1878. From his testimony before the Special House Committee we quote this:

The Chairman. You were a journeyman machinist when you went to the Midvale plant, were you?

Mr. Taylor. Yes; I may say, Mr. Chairman, that my father had some means, and owing to the fact that I worked during my first year of apprenticeship for nothing, the second year for $1.50 a week, the third year for $1.50 a week, and the fourth year for $3.00 a week, I was given, perhaps, special opportunities to progress from one kind of work to another; that is, I told the owners of the establishment that I wanted an opportunity to learn fast rather than [earn] wages, and for that reason, I think, I had specially good opportunities to progress. I am merely saying that to explain why in four years I was able to get through with my apprenticeship as a patternmaker and as a machinist. That is a very short time, as you will realize. I may add that I do not think I was a very high order of journeyman when I started in.

That he persisted with his apprenticeship despite the early restoration of his eyesight and his strong distaste for manual

[1] "Success" lecture. Incidentally these quotations will serve as specimens of the literary style which, while devoid of any natural gift or inclination for writing, he acquired by force of will.

labor, admits of various explanations. It is probable that the trade of patternmaking, calling for ability to read and interpret complicated mechanical drawings, had special fascination for him because he felt stirring within him the power of invention, the Yankee ingenuity, that had appeared in his mother's father, uncle, and grandfather. Again there is the fact that his excursion into that workshop was for him, with his birth and breeding and surcharged as he was with boyish curiosity, a regular lark, the exploration of a new world. And this brings us to something of major importance, if only because of the light it will throw on the general experience he was destined to have in industry.

"In a world composed of matter," says an anonymous newspaper writer, "the child's adventures and education consist largely in exploring matter. He wants to see what everything is made of. His tactile sense and curiosity are unbounded. He is attracted by everything he sees. He is a born inspector and investigator of everything." Practically all of us begin that way — no boredom, no wearisome routine, nothing dull or prosaic or colorless; surrounding us is an infinite variety of astonishing sights, sounds, shapes, and motions, and herein we repeat in our individual lives the childhood of the race.

Few of us, however, *stay* that way. Our senses soon cease to be free and open; we become shut up in our little selves; we fall into a lethargy, a kind of sleeping sickness; the surface aspect of things becoming with us an old story, the deadening delusion comes over us that this is the *whole* story. So we fail to establish any intimate contact with that "thousandfold Complexity of Forces" out of which all things proceed, and to learn how these forces can be directed to new issues as the conditions governing their operation are changed. Indeed, we are fortunate if, having early fallen into the habit of accepting things as they are, we do not become opposed to all change, do not end with a profound skepticism that things can be made better. And here we have the explanation of the ingrained conservatism of the mass, the conservatism against which Taylor throughout his career beat and beat until he wore himself out.

But so far we have had only part of it, the other part being this: The problem of all evolution, personal, racial, and mechanical, is to hold fast to what is good and add to it what can be changed for the better. Apparently, however, the mass of humanity, while losing the free, open sense and in consequence the curiosity of the child, largely retains the child's shallowness, his undeveloped intellectual faculty and power of self-control.

That the curiosity of the child is good, there can be no doubt, since it is the mark of the scientific spirit. Add to this curiosity the depth and strength and the ripe intellectual faculty of a man, and there you have the scientist. To be sure, greatness as a scientist can come only through great concentration of curiosity and intellectual faculty in some one field, and such concentration is neither practical nor desirable for all. Nevertheless, the lives of great scientists all remind us we can make our lives sublime by becoming scientists in some degree.

It is important that we value correctly, not only the free, open sense to be retained, but also the intellectual faculty to be developed. It is only through such development that anyone can attain to the full status and stature of a man. Looking at it from the racial point of view, we may say that man came into the world when what we call Spirit, ever struggling for a higher expression of itself in the inert matter upon which it had to work, catastrophically developed in the animal best suited for it this thing we call the intellect, just as it had developed in this and other animals the thing we call the eye. The intellect is, in fact, a higher kind of an eye. If with the ordinary eye we can see a stone wall, we can with the intellect see *into* the wall. And this because the intellect has power to judge, to analyze, to abstract, to synthesize, to classify, to reason. It can compare one object with another to note likeness or unlikeness, agreement or disagreement. No matter how many qualities or attributes a thing may possess, it can separate them one from another, and one at a time abstract a quality or attribute and so make that the sole object of its judgment. And having these powers of analysis, abstraction, and judgment, it has endless power to synthesize, or construct new combinations, and to classify, or group substances and qualities in accordance with their likeness or agreement and give them names. And out of the intellect's power to classify comes its ability to reason, or go through the process of affirming that whatever is true of an entire class must be true of any object comprehended in it. Certainly it is only as this intellectual faculty is present and brought into play that curiosity and the observation born of it can be anything more than idle, or can be so controlled as to lead to *creative* thinking. In fine, the great thing is not merely to observe, but to observe *deliberately*, *critically;* or, in John Dewey's words, to have "observation preceded by, accompanied by, and succeeded by *taking thought.*"

Never losing the child's instinct to explore, inspect, and investigate, and never suffering aught of diminution of his youthful enthusiasm for improvement and progress, Taylor, of course, fully developed those powers of the intellect to which we just have called attention. We shall see, in fact, how capitally they entered into the upbuilding of his system of management. Here it is to be brought out that his intellectualization of industrial management *was preceded by the intellectualization of himself* — from his earliest boyhood, apparently, he strove to intellectualize all the departments of his own being, and thus manage his life as a whole in accordance with reason, right arrangement, and systematic regulation.

And now let us see how in all this he proved himself the true spiritual child of the advanced Puritanism represented by Benjamin Franklin.

Everyone will recall how Franklin drew up his table of the thirteen real moral virtues, and how diligently he exercised himself to attain them. But, for us, the significant feature of his enterprise was the realistic spirit in which it was conceived: the bold attempt to ground the virtues on reason and experience rather than authority; the assertion of his doctrine "that vicious actions are not hurtful because they are forbidden, but forbidden because they are hurtful, *the nature of man alone considered.*"

Having taken this ground, it became necessary for him to explore the nature of man and the universe. So Puritanism, which, in Robinson and Mather, was predominantly rational, becomes in Franklin predominantly scientific. With magnificent fresh moral force, he seeks for the will of God in nature, and applies his discoveries with immense practical benevolence to ameliorating the common lot of mankind, and to diffusing good-will among men and nations. . . . His vision of the good life includes bringing every faculty of mind and body to its highest usefulness.[1]

This truly was also Frederick Taylor's attitude and course. It might be thought that he had too many negative virtues, and that they savored of the goody-goody. He did not drink, and would not permit anything alcoholic to be served in his home. He did not partake even of such stimulants as tea and coffee. He did not use tobacco in any form. But these self-imposed prohibitions were not, strictly speaking, based on moral considerations, but were grounded on "reason and experience." They were, in fact, based on economic considerations as applied to himself personally; were the result of a truly scientific analysis of ways to conserve one's forces.

In like manner is to be explained his devotion to simplicity of attire, of dressing only for utility. Here he economized

[1] Stuart P. Sherman in *Atlantic Monthly*, September, 1921.

thought for his work. Another consideration that later entered into it was that as he wished his "new vision" to prevail among working people as among others, he would keep his dress from acting as a separating influence between him and them. Like Franklin, he deliberately elected never to be rich; and this decision appears to have been based on his observation of the tendency of great wealth to dehumanize its possessor and generally to act as a separating influence from the mass.

In practically all his writings he avoided the personal pronoun of the first person singular. Modesty was inherent in his nature, as it must be in the case of all truly scientific men. Nevertheless, much of his modesty was calculated; observation and reason teaching him that the more you keep your personality in the background, the more chance your ideas have of influencing others. One of his close associates has said that he could make better use of other men than they could make of themselves; and the success he had in this particular may be largely attributed to his deliberate course of making it easy for those he worked with to believe that the ideas he instilled in them were their own, or that what they did was the important thing or even the whole thing.

Back of all this intellection of his can be seen the grand aim of *control*. The importance he placed on control cannot be exaggerated. "*Character*," he wrote, "is the ability to control yourself, body and mind; the ability to do those things which your common-sense tells you you ought to do; the ability above all to do things which are disagreeable, which you do not like. It takes but little character to do difficult things if you like them. It takes a lot of character to do things which are tiresome, monotonous, and unpleasant."[1]

His control, naturally, had its imperfections. Certainly, as a young man, he conspicuously failed to regulate his life properly in the matter of cultivating the power to relax and

[1] "Success" lecture.

rest. In other particulars, again, he probably placed too much emphasis on control, and so made his philosophy excessively austere. We know that the cosmic cocktail of most of his Puritan forbears, distilled as it was almost solely from the Hebrew Scriptures, would have been much improved by a dash of Greek spirit; and without being entirely blind to it, he himself apparently was inclined to lose sight of the fact that the goal of spiritual striving is not the suppression or elimination of Nature, but the lifting up, idealization, and exaltation of Nature. If he was not without genuine appreciation of artistic achievement, the mental attitude and viewpoint of the artist hardly came within his ken, however much in his latter years he strove to comprehend it. These things, however, simply bespeak his human limitations, and particularly his consuming zeal; and surely there can be no successful challenge of his general position that the aim and end of all thinking and all knowledge is control: *first* the control of self; then through this the control of things external to self.

All his principles he learned by practicing them; and just because the manual toil involved in his apprenticeship was disagreeable, he undoubtedly got satisfaction, high and grim, out of doing it; entering as early as eighteen on the path of self-discipline by which one's simple purpose becomes to one as iron necessity.

Austere as was his personal philosophy, it appears to have been at all times relieved from gloom by his love of mischief and his amiability and sociability. Most decidedly *he* would have objected to bear-baiting, not because it gave pleasure to the spectators, but because it gave pain to the bear. He loved to see people happy, even if he thought they often were mistaken as to where real happiness lay, and any suffering, whether human or animal, sickened him. And though while serving his apprenticeship he worked hard ten hours a day, he still found time for indulging his social nature.

CHAPTER VI

HIS CALL TO GO ON IN INDUSTRY

AS a matter of fact there was included in his sociability a full measure of those qualities which go to form a genius for friendship; namely, geniality, generosity, thoughtfulness, tenderness, and, above all, magnanimity and loyalty. And from his infancy he appears to have had a marked faculty for winning the affection of persons of all social ranks.

It was our privilege to meet several of the persons who served as helpers in his parents' household or in that of a family connection, and the things they remembered about him, small in themselves, are not without their large significance. Here, for instance, is something that, after forty years, still made Amanda Montier, who was Emily Taylor's waitress, heartily laugh as she thought of it: Thomas Hughes, the family's colored coachman, had a wife and a regular stepladder of babies. Up the steep Church Lane hill that led from Main Street to Ross Street slowly struggled one day Hughes's wife, pushing a carriage containing no less than three of her youngest, while several more of the children trudged alongside. Who now, stepping briskly along, should overtake this colored family on the hill but "Mister Fred," and what does that "grand and noble" young man do but seize the handle of the carriage and push that load of pickaninnies all the rest of the way home!

Significant this incident surely is of what remained one of Taylor's fundamental traits. It is related of Napoleon at St. Helena that "when walking with Mrs. Balcombe, some servants, carrying heavy boxes, passed by on the road, and

Mrs. Balcombe desired them, in rather an angry tone, to keep back," but "Napoleon interfered, saying 'Respect the burden, madam.'" And it is reported of Emerson that "he was drawn more to Napoleon by this speech than by any other story told of him, and he frequently used it as a lesson to his children and others, of honor and consideration for laborers and servants." All this well expresses the mature attitude of Taylor. He regarded it as a necessary part of his sons' education as gentlemen that, through actual experience, they learn respect for a day's work and the men who do it. The notion that household servants are, as he expressed it, "distinctly inferior beings" made him white hot with indignation. He had an idea that it would be a good thing for young women, born to comfort or luxury, to serve a year or two as household helpers themselves, or, say, as employees of a hotel. He not only "respected the burden," but helped with it. "One day when I was walking with Mr. Taylor along Boylston Street, Boston," writes an associate of his, "we caught up with a workman who was carrying a heavy plank to an office building in course of construction. Mr. Taylor got his shoulder under one end of the plank and walked with it to the place where it was to be dropped, this being in line with our travel."

The piano lessons he took while abroad were sufficiently thorough to enable him to give creditable performances of such compositions as Weber's "Invitation to the Dance," even if, in his mature years, he touched the piano only when some outbreak of the prankishness he never lost inspired him to give a burlesque performance. The dancing lessons he took abroad also were of use to him only in his boyhood's days. While he continued with his dancing he pursued a course affording not only a most interesting example of how he thought everything out but also a fine illustration of the "ego-altruistic" philosophy that throughout his life governed his personal and business relations. Before going to a dance he used to list, as systematically as he could, the attractive girls on the one hand and the "wallflowers" on the other hand, with the object of dividing his time equally between them. You see, it was the "split fifty-fifty." He had no morbid passion for self-sacrifice. But he was entirely willing to be reasonable and strike with society a just balance. He recognized that he was both an individual and a social being.

Even while he worked ten hours a day in a machine shop, he retained his membership in a choral society and in the Young America Cricket Club, which later was merged with the Germantown Cricket Club. A tenor, he used to sing with deep feeling "A Warrior Bold." In the choral society he stood near David Bispham, destined to become famous as a barytone. Often in his later years Taylor, in deprecating the luxury of the modern country club, used to point, by way of contrast, to the simplicity of things at the Young America Cricket Club. Though he played cricket, he cared more for baseball. One of the leading activities at the Cricket Club was the giving of amateur theatricals, and in these performances he easily was a star.

He was not, on the whole, what you would call a clever man. Certainly his forte was not mental agility, but systematic observation and sustained thinking concerning the results of his observation. In one particular, however, he had marked cleverness: as a mimic he probably could have earned a good living on the professional stage, and this seems to have been a part of a broadly dramatic gift which, in his highly unique way, he was destined to capitalize in his business.

One of his best performances at the Cricket Club was in the part of a broken-English-speaking German doctor; but what this virile young man was most celebrated for was his female impersonations, these being made necessary by the fact that only the members of the club, who were all young men, took part in the performances. Helped by his sister to prepare his costumes, Fred Taylor impersonated young ladies with such fidelity as entirely to deceive even her who, of all those in the audience, had the most reason to be familiar with his true personality.

Once when he was to appear in the rôle of a young woman, he and his friend, Joseph Clark, who also was to appear in such a rôle, went in advance to a photographer's and made an engagement to have their pictures taken, but without telling the photographer they were coming in feminine costumes. When they arrived in a carriage at the appointed time, and Taylor, carrying out then and there his rôle of young woman, asked to have their pictures taken on the spot, the photographer protested that he could not do it, as he had an engagement at that hour with two young men. Working himself up into a feminine pet, Taylor proceeded to argue the matter, and as the photographer was beginning to lose patience, he nearly bowled that man over by suddenly changing to his natural voice and exclaiming, "Now, look here, why the hell can't you take our pictures!"

The foregoing expletive will serve to introduce us to a most decidedly curious fact about this descendant of a long line of Puritans and Quakers: while serving his apprenticeship, he not only picked up a habit of swearing, but deliberately cultivated and retained it.

Swearing, of course, is a sort of mill language, and of the steel mill particularly. These mills are not elegant places. There is a deal of dirt and sweat. There is much human nature in the rough. And they are not quiet places. Violent hammer blows are struck. The grinding of metal on metal is harsh. You have to shout to make yourself heard. And all this cannot help but affect the mentality of those who work there. As a boss, you often have to resort to violence of language, if only to keep your men from doing things that imperil their limbs and lives. It ought to be readily recognized that this swearing does not necessarily involve any disrespect to the deity; that, on the contrary, it usually means no more than what a teacher in a girls' school means when he says, "Now, young ladies, I am thoroughly in earnest." Very likely it should not be necessary to swear in a mill, but with characteristic thoroughness Taylor wished to possess himself of whatever advantage there might be in as nearly as possible speaking the language of those with whom he dealt, of meeting them on their own level. He often regretted his inability to swap with his workmen a chew of tobacco. Apparently he did not so much swear at men as swear to them, and this, as he went on, was for the benefit not so much of the rank and file as of men in the management, notably foremen.

However, his swearing did not end here. With his intense feeling, he was prone quickly to exhaust the ordinary resources of human speech when talking to people in general. Then, it is probable that, having placed so many interdictions upon himself, he felt an imperative need of indulging himself in at least one vice. Certainly his swearing was identified with his love of mischief; the way he would let loose a few good ones in the presence of the ultra-respectable and the ultra-staid suggested the act of a small boy who explodes a firecracker under the chair of a dignified senior. His swearing was indeed unique. He did not swear when most men would, and he did swear when most men would not dream of it. As far as we have heard, he never swore on the golf course. But he did swear when lecturing at Harvard, though, as was the case when he was in his own home, it was practically all done in telling stories and in quoting other men.

As was true of all his other activities, he steadily improved his swearing, made it less amateurish and more artistic; but the fact is that he never became able to do it *quite* like one to the manner born. The high-grade workmen with whom he came in contact appear invariably to have been first puzzled

"FRED" TAYLOR AS "MISS LILIAN GRAY"
An impersonation in amateur theatricals

and then amused by it. They easily could feel the incongruity between this habit and his general character. And when we consider that there is nothing a self-respecting man resents more quickly than a conscious attempt on another's part to come down to his level, it is significant that even those workmen who saw through Taylor's swearing were not offended by it, but were willing to give him credit for good intentions.

Few indeed were the people in any calling who were offended. On account of its contrast with his Chesterfieldian manners, its very amateurishness, its suggestions of a naughty boy attitude, its transparent simplicity and enthusiastic good faith, most people undoubtedly found that it lent to his personality an added and a piquant charm. "Mr. Taylor," says Miss Ida M. Tarbell, "never seemed to me more of a gentleman than when he was swearing." And we know of one dignified elderly gentleman who was wont to remark, plaintively: "I wish I could see Mr. Taylor oftener; I do so love to hear him swear."

It hardly should be necessary to say that his language never partook of anything foul. He had an inbred distaste for that sort of thing which was akin to physical fastidiousness. "The slightest vulgarity of any kind," says an old friend of his, "not only disgusted him but drove him off. I have seen him leave the theatre for this reason, and I have seen him leave groups of distinguished men for the same reason. He always contrived to do it in such a way as not to give offense but to leave the impression that he was not interested."

We may imagine that no feathered, non-webfooted mother ever was more amazed and bewildered upon seeing her chicks take to water than was Emily Taylor when her offspring brought back from the shop a readiness to use words beginning with a big, big D. But that young imp, when reproved, would only laugh and say: "Why mother, you don't understand the reason for it." The incident seems to us symbolic.

Not the least of the many thrilling discoveries he made in the shop was that men who, tobacco in mouth, slouched along the streets in greasy overalls, who hardly looked up and scarcely were willing to speak to you politely as you passed them, who had had little formal schooling and could not speak grammatically — that such men were likely to prove, when at length you got to know them, as mentally keen as anyone else, besides being all-around good fellows.[1] One workman in particular made a deep impression on him.

The very best training I had [he wrote in 1910] was in the early years of apprenticeship in the pattern shop, when I was under a workman of extraordinary ability, coupled with fine character. I there learned appreciation, respect and admiration for the every-day working mechanic.

To his own people he remained absolutely loyal. Devoted as he was to his work, he never had any doubt as to where, first of all, his allegiance lay. His thought began with his own household, and from this was extended, through his ties of blood and friendship, to the world at large. So long as his mother lived, he seldom was so busy that he could not pay her calls of affection and respect. He remained his father's "Bub."

Nevertheless, in the true Puritan spirit of revolt, he took into his hands in his youth "the sceptre of his own control." In the workshop he came in contact with something enlarging, and that the years but served to reënforce this vision will appear from what Birge Harrison writes us:

About the last time that I saw my friend was at a little dinner at the Hotel Bellevue-Stradford in Philadelphia, where the guests present, besides our two selves, were Mr. Taylor's sons and a young ironworker from one of the big steel mills in which he was interested. This youth's

[1] Substantially the language used by Taylor in referring to his apprenticeship days in an address delivered in 1909 before the Society for the Promotion of Engineering Education.

mother was a washerwoman, but he was a fine, manly fellow, and the three boys went off to the theatre together at the end of the repast. Democracy with Fred was no theory; it was a rule of life, and he felt that if he could so train his own sons that they too should understand — should see and truly believe this greatest of all truths — he could leave them no finer legacy.

It was not merely that he had his sympathies enlarged while serving his apprenticeship. He heard a call, saw a beckoning, received a summons to prepare himself for the "ardor and discipline and renunciation" of a typical Puritan pilgrimage. He had his "eye on the bad industrial conditions which prevailed at the time and gave a good deal of time and thought to some possible remedy for them." In fine, he already had formed the habit of observing *critically*, and it was this that led him, in 1878, when he was twenty-two, to go to Midvale.

We are told that "in one of those brilliant divagations with which Mr. H. G. Wells is wont to enrich his novels," he says:

When the intellectual history of this time comes to be written, nothing, I think, will stand out more strikingly than the empty gulf in quality between the superb and richly fruitful scientific investigations that are going on, and the general thought of other educated sections of the community. I do not mean that scientific men are, as a whole, a class of supermen, dealing with and thinking about everything in a way altogether better than the common run of humanity, but in their field they think and work with an intensity, an integrity, a breadth, boldness, patience, thoroughness, and faithfulness — excepting only a few artists — which puts their work out of all comparison with any other human activity. . . . In these particular directions the human mind has achieved a new and higher quality of attitude and gesture, a veracity, a self-detachment, and self-abnegating vigor of criticism that tend to spread out and must ultimately spread out to every other human affair.[1]

[1] Quoted in *The Mind in the Making*, James Harvey Robinson; Harper & Brothers, 1921. Mr. Robinson's book is essentially a plea for bringing the mental attitude that inspires the natural sciences to bear on human affairs — the very thing Taylor did in industry.

When he wrote these words, Mr. Wells could not know that, as early as the 1870's, this precise mental attitude had been taken into industry to be applied to its management in a way destined to have an ever-widening influence. Few of us have known it in all these succeeding years; but looking back now, we can see that it was a dramatic moment — the herald, indeed, of what Taylor, in view of the novelty of this attitude and gesture in industry, was fully justified in calling a "great mental revolution."

BOOK II

HIS GENERAL WORK AT MIDVALE

A MAN is relieved and gay when he has put his heart into his work and done his best. . .
Trust thyself: every heart vibrates to that iron string. Accept the place the divine providence has found for you, the society of your contemporaries, the connection of events. Great men have always done so, and confided themselves childlike to the genius of their age, betraying their perception that the absolutely trustworthy was seated at their heart, working through their hands, predominating in all their being.

EMERSON'S *Self-Reliance*

CHAPTER I

THE INDUSTRIAL WORLD IN 1878

THE United States has no metropolis in the Greek and general European sense. Certain cities may be supreme in certain particulars, as New York in finance, but there is no city whose supremacy is general. For many years Philadelphia has ranked in size after New York and Chicago, and throughout these years it has been a publishing, commercial, and financial centre of first-rate importance. All along, however, its prosperity mainly has rested on its highly diversified manufacturing; its chief products being machinery, locomotives, iron wares, ships, carpets, woolen and cotton goods, leather, sugar, drugs, and chemicals.

The first successful locomotive, Old Ironsides, was built in 1832 at the great Baldwin Locomotive Works in Philadelphia. It was a carpet made in Philadelphia about 1791 that led Alexander Hamilton to place a tariff on all imported carpets, and this is said to be the origin of the whole American protective tariff system. What is certain is that Philadelphia has been the leading stronghold of this tariff system ever since it has been in vogue. Frederick Taylor believed that a tariff easily could be made too high. Still, a protective tariff man he was. Though, because of his disapproval of the actions of both William H. Taft and Theodore Roosevelt at that time, he in 1912 voted for Woodrow Wilson, he wrote a friend that he "did it with some misgivings, on account of the tariff question," and in the midst of this campaign he said in a letter: "I look upon our protective policy as one of the finest that has been introduced into this country. While I think the duties ought to be lowered, I am a strong protectionist."

At the present time, the city stretches over an area of about 130 square miles. Except in those sections that the city has gained through annexation rather than expansion, the original checker-board street plan has been closely followed out as the city has grown. The two main streets are Market and Broad. Market Street runs east and west, Broad north and south. In a square at the intersection of these streets stands the $25,000,000 City Hall. Market Street long has been known as a mystic line separating the social sheep from the goats. No " nice " people, so it is said, are to be found north of this street — that is, not unless you keep on going north and a little west of north far enough to reach the hills on which is situated Germantown. What this principally means is that it is in the bottom-land section to the north of Market Street that practically all the city's manufacturing is done, and that, besides the factories, there are here rows and rows of working people's homes, mostly two-story brick structures, neat enough in the main, but in their box-like uniformity and cheek-by-jowl construction, making anything but an esthetic appeal.

At the extreme northwest of this manufacturing district, about four miles out from the City Hall, is the subsection called (strangely enough from that social viewpoint) Nicetown; and it is here, at the very foot of the slope leading to Germantown, that we find situated, where they have been ever since the enterprise was established in 1867, the works of the Midvale Steel Company.

Now, all the probabilities are that this industrial plant, which was within two miles of young Taylor's home in Ross Street, Germantown, was the only one existing in this country in 1878 and for many years later which would have given Taylor anything like the opportunity to follow his natural bent for scientific investigation that for a decade he there was destined to enjoy.

With a president who was devoted to and deeply versed in scientific methods, and having for its other principal officers men of scientific education and attainment, the Midvale Steel Company stood out, in 1878, like a beacon light in American industry.

To appreciate this, we must have some understanding of what was then the general situation.

It will be recalled that the year 1878 was on the threshold of the period in which the development of machine-tools, stimulated by the invention of the steam engine in the latter part of the eighteenth century,[1] reached a point marking the real beginning of large-scale production as we know it to-day.

From 1880 to 1890, the number of wage earners in this country increased by one and a half millions, a growth twice as great as in any preceding decade. The gain in capital during the eighties was three and three quarters billion dollars, or more than three times as great as in any preceding decade.

Even more phenomenal and significant than this expansion of manufacturing was that revolution in method known as the introduction of large-scale production. Government reports and general opinion unite in placing the date for this transformation at about 1880. In the iron and steel industry the movement was well under way in the seventies, but in a greater number of industries the apex was reached in the eighties.[2]

As it was in England that the industrial revolution ushered in by the steam engine began, it is not strange that mechanical

[1] Previous to this time, machine-tools indeed were few, crude, and of limited application, due to the fact that there was not, save only in the case of water power, sufficient power to drive them. And there was no thought of transmitting power from water, except for very limited distances. "The steam engine, however," says the *Encyclopedia Britannica*, "changed all this. On the one hand the hitherto unheard-of accuracy of fit required for its working parts created a demand for tools of increased power and precision, and on the other it rendered the use of such tools possible in almost any situation. Thus, acting and reacting on each other, machine-tools and steam engines have grown side by side."

[2] Horace B. Drury, address in 1916 at Ohio State University.

engineering should there have made its first advances in the direction of a true science. In his *Economy of Machinery and Manufacturing,* published in London in 1832, Charles Babbage, the eminent mathematician and mechanician, wrote: "There is perhaps no trade or profession existing in which there is so much quackery, so much ignorance of the scientific principles, and of the history of their own art, with respect to its resources and extent, as is to be met with amongst mechanical projectors." Called at the time a "hymn in honor of machinery," Babbage's book appears to have borne early fruit in his country as it was a plea for the correction of the evil referred to in the words we have quoted.[1] At all events, it is certain that by the 1870's the English, notably in the case of the firm of that great engineer, Sir Joseph Whitworth, had made remarkable strides in the scientific designing and construction of machinery.

Elsewhere in Europe also much progress had been made as early as 1878 toward the general recognition by practical men of mechanical engineering as a science.

In this country, on the other hand, the very idea that there could be a true science of mechanical devices continued to be generally scorned, and so low a place did the whole engineering profession then occupy in the general life of the community that even an engineer with a college degree was not likely to be considered eligible socially. Here is Taylor's own vivid picture of what the situation then was in this particular:

> One of the most recent developments of the experts has been that of the Science of Engineering. So recent is this development that I can remember distinctly the time when an educated scientific engineer was looked upon with profound suspicion by practically the whole manufacturing community.

[1] Presently we shall see that as Babbage's book was a plea for a great deal more than the scientific designing of machinery, it was a remarkable foreshadowing of Taylor's lifework.

The successful engineers of my boyhood were mostly men who were endowed with a fine sense of proportion — men who had the faculty of carrying in their minds the size and general shape of parts of machinery, for instance, which had proved themselves successful, and who through their intuitive judgment were able to make a shrewd guess at the proper size and strength of the parts required for a new machine.

It was my pleasure and honor to know intimately one of the greatest and one of the last of this school of empirical engineers — Mr. John Fritz, — who had such an important part in the development of the Bessemer process, as well as almost all of the early elements of the steel industry of this country.

When I was a boy and first saw Mr. Fritz, most of the drawings which he made for his new machinery were done with a piece of chalk on the floor of the pattern room, or with a stick on the floor of the blacksmith shop, and in many cases the verbal description of the parts of the machines which he wished to have made were more important than his drawings. Time and again he himself did not know just what he wanted until after the pattern or model was made and he had an opportunity of seeing the shape of the piece which he was designing. One of his favorite sayings whenever a new machine was finished was, "Now, boys, we have got her done, let's start her up and see why she doesn't work."

The engineer of his day confidently expected that the first machine produced would fail to work, but that by studying its defects he would be able to make a success of his second machine.

Do not for a moment misunderstand me. I am not in the smallest degree belittling Mr. John Fritz. He was one of the greatest men of his time — a man of remarkable originality, force of character, and general engineering ability. What I am endeavoring to do is to make it clear to you that the Science of Engineering is a very recent development, as are, in fact, the sciences of chemistry, physics, and even astronomy.

The Science of Engineering started only when a few experts (who were invariably despised and sneered at by the engineers of their day) made the assertion that engineering practice should be founded upon exact knowledge of facts rather than upon general experience and observation.[1]

As it was with mechanical engineering in 1878, so it was with chemistry and metallurgy, those two sciences on which all the metal industries rest today. Here, indeed, is a curious fact, or one that probably will seem so to many of the younger generation: Though civilization did not begin until man began to learn how to use metals, it is seldom that the metals as supplied by nature are entirely suited to man's use. Each has its strong and its weak points. To build up a real civilization, man had to mix nature's metals in combinations called alloys, so that the weak points of one would be offset by the strong points of another. However, it was not until the late nineteenth century that man began to make the alloying of metals a matter of really scientific study. Previous to that time, such valuable combinations as were discovered were mostly the result of chance mixings. And it took years and years to convince the general run of people in the metal industries, at least in this country, that the old empirical method was not good enough.

That all our sciences, even physics and astronomy, are comparatively recent may readily be explained by the fact that truly scientific thinking is comparatively recent, at least as far as direct attachment with the past is concerned. Several thousand years before Christ, the Egyptians must have done a deal of scientific thinking to have accomplished their mechanical wonders. And did not Aristotle, with his genius for analysis and classification, trace out the laws of correct thinking or reasoning some three hundred years before Christ? But again and again such critical thinking as was done in the past fell into a profound desuetude owing to the burden of sus-

[1] From address on "Laws versus Private Opinion as a Basis of Management" made by Taylor in 1914 at Young Men's Christian Association in Philadelphia.

taining it, so that each recurrence of it summoned men to a practically new way of thinking and thus was more like a revolution than a renaissance.

Again there is the fact that, however much scientific thinking may have been done previous to the writings of Francis Bacon in the early seventeenth century, it remained for these writings definitely to promulgate the inductive philosophy which, consciously or unconsciously, must actuate all truly scientific investigation: — Conclusions cannot go beyond assumptions; if your assumptions are wrong, correct reasoning will not keep your conclusions from being false. Don't assume. Don't guess. Seek the facts, not to support an assumption, but solely to learn the truth. Seek *all* the facts; not only those that can be gathered in, but also those that can be developed by experiment. Verify and organize your facts; subject them to intelligent and unbiased analysis. Then, and not until then, resort to deduction and get your laws.

In passing it is to be noted that Taylor's youth was in the years when two marvelous examples of what comes from following the Baconian philosophy were working, at least in academic and other cultural circles, a prodigious change in man's apprehension of this world in which he lives. It was in 1859 that Darwin published the *Origin of Species,* and in 1871 that he published the *Descent of Man.*

All this signifies that Taylor appeared on life's scene at the onset of a time of great intellectual, religious, industrial, and social upheaval such as attends the breaking up of an old order to give place to a new. And back of it all was the new impetus lent to the old spirit of inquiry by the establishment of correct methods of investigation.

No form of science, however, was destined to gain general recognition in American industry for *many* a year. In fact, old-timers in industry are inclined to believe that it was not until about 1898, the year of our war with Spain, that the generality of executives in this country first began to wake up, even in connection with such things as chemistry, metallurgy, and mechanics, to the dollar-and-cents value of scientific as opposed to rule-of-thumb methods. It is certain that the decade 1900–1910 was one of brilliant developments in metallurgical chemistry especially, and a large part of this can be directly attributed to Taylor's metal-cutting investigations. Apart from metallurgy, the decade 1900–1910 saw a great awakening in American industry to the value of the scientifically-trained expert in general; this being reflected in the much greater attention given at colleges and universities to specialized industrial education.

It is pretty safe to say that, previous to the decade 1900–1910, it was characteristic of Americans as a race to rely for their industrial success almost entirely on their superior natural resources and on what they complacently believed to be their own superior natural ability. Evidence of this is found in the *Monthly Consular Reports of the United States* for January, 1905, which included an account of the impressions of American industry gathered by the German educators, scientists, merchants, manufacturers, and engineers who had visited the recently-held St. Louis Exposition. These Germans advised their fellow countrymen that they need not fear the competition of American industry, because the advantages from our natural resources were offset by certain disadvantages.

Of these disadvantages, especially significant was that common American temperament which they described as a state of careless confidence, a "feeling of complacent satisfaction with everything American"; a feeling that in industry and in commerce, as in other manifestations of national life, there is no need of conscious, concerted action looking towards improvement and greater efficiency. As one expression of this careless confidence, they cited the absence of special industrial education and the "reliance on a general and more or less superficial education, together with natural adaptation."[1]

[1] *Industrial Education*, by Dr. Harlow S. Person, p. 4.

So now this brings us to the question: if right up to and through the 1890's it was characteristic of "hard-headed" business men to associate science in all its forms with academic detachment from the world of practical affairs, how did it come about that such a different order prevailed at Midvale? In our next chapter we shall have the answer.

CHAPTER II

FAR-ADVANCED MIDVALE

JUST after the close of the Civil War, or in 1867, a group of Philadelphia capitalists, in furtherance of their project to establish in their city a general steel-manufacturing business, brought over here one William Butcher, a product of the cutlery industry of Sheffield, England. For its time it was a very venturesome project, and as it was conducted at the beginning it was foredoomed.

Steel, we know, is a modified form of iron, not occurring in nature, and is superior to iron in hardness and in elasticity or tensile strength. How iron is modified so as to make steel, is a subject upon which volumes have been written. Suffice it here to say that all forms of steel have their beginning in a process mainly having to do with removing the excess of carbon found in iron as it is first recovered from the ore. By this process is produced the metal that may be called ordinary steel to distinguish it from various special steels that are made by the addition in various proportions of various alloys.

Until the electric furnace was developed commercially along about 1910, the prevailing methods of making ordinary steel were limited to the crucible, the Bessemer, and the open-hearth. The crucible process is hoary with age; up to the middle of the nineteenth century it was substantially the only process, and until the electric furnace was developed it remained the only way in which could be produced steel capable of being so treated as to make it suitable for cutting tools, weapons, and other things requiring steel of special hardness. The Bessemer process, developed commercially in 1858, so cheapened the production of steel as to make it practical for such things as building material. The open-hearth process, developed a little later, gave a more dependable product than did the Bessemer, and therefore open-hearth steel became in special demand for rails and other things that must withstand heavy pressure and wear.

By many persons in the trade the year 1867 is fixed upon as about the time when the open-hearth process was perfected commercially; and this was the year when those Philadelphia capitalists brought William Butcher from England. Not only was the open-hearth process then in its infancy, but the whole steel industry, as we know it to-day, had hardly begun to develop. It was not until about 1880 that steel, for purposes other than those of tools, began to replace iron on a large scale; manifest as were its advantages over iron for many uses, it had slowly to make its way against prejudice. Moreover, there is the fact that the sciences of chemistry and metallurgy had not yet gained any lodgment in this industry.

Butcher's Steel Works, we believe, was the name under which the new Philadelphia company first did business. Apparently the only steel-making process that the former Sheffield cutlery man was sure of was the crucible; but the locomotive tires he made by this process proved as unreliable as they were costly. Eventually the works came almost to a standstill, and a heavy loss was incurred. The reorganization of the business under the name of the Midvale Steel Company then was undertaken by two of its principal creditors: William Sellers, head of William Sellers & Company, manufacturers of machine-tools, and E. W. Clark, the banker. Sellers and Clark became owners of equal amounts of stock, and between them they owned all of it, with the exception of about a hundred shares held by James A. Wright, an exporting and importing merchant. Of the reorganized company, Sellers, in 1873, became president.

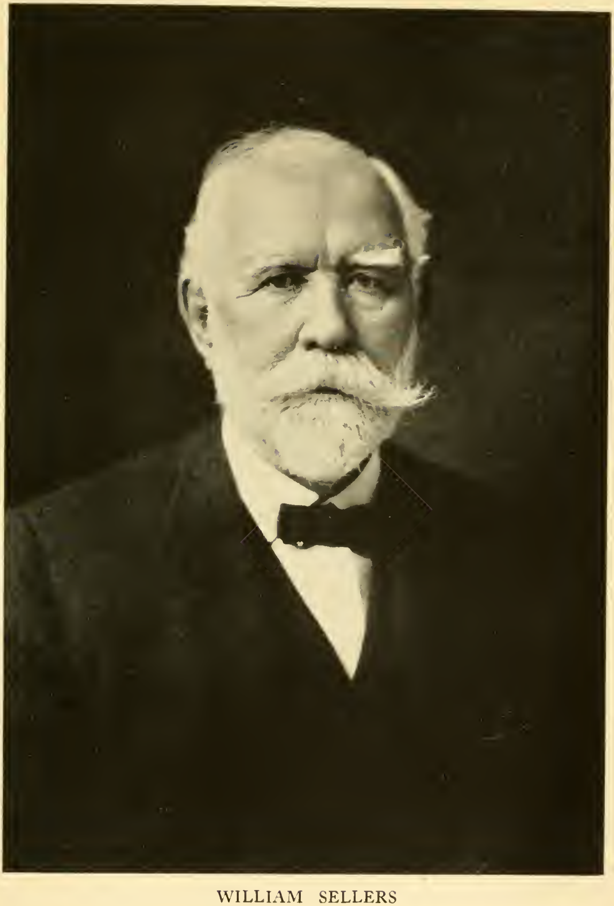
In his writings and addresses, Taylor was wont to refer to

William Sellers as "undoubtedly the most noted engineer in this country in his time," "a truly scientific experimenter and a bold innovator," and "a man away beyond his generation in progress." That these encomiums were no more than just, we may readily believe. In the nineteenth century, Sellers presented in his scholarly habit of mind a remarkable contrast to what was generally true of Americans in industry, and there can be no doubt that, above all other persons in industry, he had a powerful influence upon Frederick Taylor in Taylor's formative years.

He was born in 1824 in Delaware county, Pennsylvania, and was a direct descendant of Samuel Sellers, one of the Quakers to come from England to Pennsylvania in 1682. All the formal education he received was at a private school especially built and maintained by his father and two relations for the training of their children. Leaving this school when fourteen, he worked for seven years as an apprentice to the machinist's trade in the shop of his uncle, John Morton Poole, of Wilmington, Delaware. But though he had little formal education, he apparently inherited a scientific bent. We read that his ancestors "had a long and memorable connection with science. From the organization of the American Philosophical Society some one of his family has always been a member of it. His paternal grandfather, John Sellers, then a member of the Assembly of Pennsylvania, was appointed by this society, in connection with three other members, to observe the transit of Venus in 1761, and his maternal grandfather, William Poole, came from England to observe the same transit and remained here." [1]

William Sellers was president of the Franklin Institute of Philadelphia from 1864 to 1867, and a trustee of the University of Pennsylvania for thirty-seven years. At the time

[1] From the memorial issued by Franklin Institute upon the occasion of William Sellers' death in 1905.



WILLIAM SELLERS

TAYLOR IN HIS MIDVALE DAYS
Age about 30; a portrait still to be found in family albums of Midvale workmen who served under him

he was managing his machine-tool business and was president of the Midvale Steel Company he also was directing the Edgmoor Iron Company; which company, formed by him in 1868, supplied all the iron structural material for the buildings of the Centennial Exhibition held in Philadelphia in 1876, and all the structural material used in the Brooklyn Bridge, with the exception of the suspension cables.

As an inventor and as a designer of machine-tools, Sellers attained a position in this country that engineers deem comparable to that of Whitworth in England. And as Sellers at the beginning had to contend here with far more primitive machine-building general conditions than Whitworth did in England, it is held that the success he achieved was the more noteworthy. Whitworth himself is reported to have referred to Sellers as the "greatest mechanical engineer in the world," and it is hard to conceive of a finer tribute to an inventor and constructor than was paid to Sellers by the International Jury that examined his exhibit of machine-tools at the aforementioned Centennial Exhibition. So great a start did Sellers gain in this country as a constructor of machine-tools that it has been said, with playful exaggeration, that he could have had a plant stretching from Philadelphia half way to New York, if only he had put as much genius and enterprise into selling as he did into constructing.

At the Sellers plant were employed at various times as draftsmen no less than three men destined to become intimately associated with Taylor in connection with Scientific Management. These, in the order of their appearance there, were Henry R. Towne, Wilfred Lewis, and Carl G. Barth. Towne, who went to the Sellers plant shortly after the Civil War (he was Taylor's senior by twelve years), left there several years before Taylor went to Midvale.[1] On the other

[1] It was in 1868 that Mr. Towne became associated with Linus Yale in the manufacture of locks and other ingenious and highly wrought forms of

hand, the employment of Lewis and Barth at Sellers' to some extent coincided with Taylor's employment at Midvale.

It was one of Sellers' beliefs that if a machine was right, it would *look* right; and there is here something of interest in connection with the career of Taylor: All grace arises from the elimination of the superfluous. Thus if Sellers viewed a machine with an artistic eye, if his machines were noted for what was then an exceptional beauty of form and line, this can be strictly related to his very practical (yet for his time very advanced) habit of weeding out non-essentials, of insisting that everything about a machine be made directly contributory to the end for which the machine was designed. It would appear, then, that Taylor's time study of labor operations, eliminating as it did superfluous motions, was the extension to the *handling* of machines of the principle to which Sellers adhered in designing them.

A striking example of Sellers' innovating spirit is seen in the fact that, along about 1876, he investigated in his machine-building plant the best shapes and angles for cutting tools, adopted standard shapes and angles, representing compromises on those used by the most experienced machinists, and attempted to have the tools used in his plant issued to the workmen ready ground to these shapes and angles with a machine of his own devising. Here before Taylor went to Midvale was a fairly close anticipation of the Taylor principle of standardization.

The rescuing of the Midvale Company from bankruptcy may be ascribed primarily to the general business ability of Sellers and Clark and to the encouragement given by Sellers, as president, to all scientific methods. But neither Sellers nor

hardware, and the Yale & Towne plant became one of the first to adopt the Taylor System. Mr. Lewis became the head of the Tabor Manufacturing Company, the plant upon which Taylor chiefly relied as a practical demonstration of Scientific Management's workings. Mr. Barth, through his mathematical genius, became foremost among those who aided Taylor to round out his system.

Clark was a practical steel man; and the credit for putting the company on its feet, as far as the operating end was concerned, belongs to two young New Englanders named Charles A. Brinley and Russell W. Davenport, ably assisted by a young Germantowner of Swedish ancestry named Guilliaem Aertsen.

Both Brinley and Davenport were scientifically trained in chemistry and metallurgy, having studied under O. D. Allen, professor of metallurgical chemistry at the Sheffield Scientific School of Yale University. That this Professor Allen was a practical man is indicated by the fact that he had been employed by that distinguished Philadelphia Quaker, Joseph Wharton, to study in Europe processes of preparing nickel, and with Wharton was an important contributor to the development of the nickel industry in this country. The founder of the Wharton School of Finance and Economy at the University of Pennsylvania, Mr. Wharton always will have the distinction of being one of the first financiers in this country to recognize the value in industry of the scientific expert, and to this far-sightedness of his he undoubtedly owed a large part of his success as a pioneer developer, not only of the nickel industry here, but also of the iron and steel industry. As Wharton was the man who induced the Bethlehem Steel Company to employ Taylor to systemize its works, we in these pages shall hear of him again.

It was in 1872, immediately following his three years' post-graduate study under Professor Allen, that Brinley came to the Midvale Company as chemist. If his was not the first chemical laboratory set up in the steel industry in this country, it was one of the very first. A year after he came to Midvale, Brinley was placed in charge of the metallurgical work or the actual steel making. And in the following year of 1874, when the chemist who succeeded him had died of malaria, he brought to Midvale as chemist his old Sheffield School room-mate, Russell W. Davenport, who had just returned from study in Europe.

Brinley had established his laboratory on the lower floor of an old four-room workman's house that stood across the tracks of the branch of the Reading Railroad that ran by the works. And so as to be near the works day and night, he had taken up his bachelor abode, with his little Scotch terrier, in one of the rooms over this laboratory — a room that was just large enough to contain a bed, a washstand, a chest of drawers, and one or two chairs. And when Davenport arrived, he took half of the bed and otherwise went to live there with his old friend.

A year after this Samuel Middleton, the superintendent of the works, who long had been a victim of anxiety and overwork, died of typhoid following malaria. And then Davenport came down with malaria. When at length he managed to recover, his doctor vetoed any return by him to the housekeeping in the laboratory. So he and Brinley rented a regular house in Indian Queen Lane, Germantown, from a widow who agreed to act as their housekeeper. And living so near this house that he became a regular visitor was that forceful young man, Guilliaem Aertsen. Upon the death of Middleton, Brinley was promoted to be superintendent, Davenport was put in charge of the steel making, and soon Aertsen was drawn into the works, eventually to become Brinley's assistant. Though he kept in close touch with his lieutenants, William Sellers came to Midvale but seldom.

To this day the path of the scientific expert is not easy. As H. L. Gantt was wont to say, " the usual way of doing a thing is always the wrong way," and to the scientific expert falls the task of breaking this news which no one hears with joy and gladness. It was, indeed, a certainty that the steel-making methods introduced by Brinley and Davenport in those early Midvale days would be violently objected to by all the " practical" men there employed. Some quit cold, saying they had lived too long to be taught by boys, and those that remained did so with grim predictions as to results. But the results were all right. An idea of the difficulties that had to be overcome may be gained from this quotation from a speech made at the works in 1888 by Davenport:

> It was no easy task; the reputation of the works for producing good material was absolutely gone. Something like 3,000 tons of steel of various kinds, and in various conditions of manufacture, were piled about the yard, regarding which little or nothing was known. The only stock-record book in existence was in the brain of old Mike Kelly, and to him Mr. Brinley would go for information, such as it was. The question of assorting this mass of material and determining its usefulness had to be solved by the laboratory, and it was to help in this work that I came to the works. By careful selection, and mixing with high-grade pig iron purchased for the purpose, all this old stuff was successfully worked into rail blooms for which we got over $100 a ton. This contract for rail blooms was with the Reading Railroad, and had been nearly canceled because the former management of the works had tried to use old ingot moulds in making the steel, and thereby put in so much phosphorus as to cause the rails to break in unloading.[1]

While this work was being done, tool steel was made by the crucible process and profitably marketed. But Midvale's first great triumph came when, despite the dismal failure made under the Butcher administration, it was decided to undertake again the manufacture of locomotive tires. The new tires were made of open-hearth steel, and it said they were the first tires successfully to be so made in this country, and possibly anywhere. The manufacture of steel axles for the Pennsylvania Railway then was taken up, and these, so we are told, were the first to stand the physical or drop test.

[1] Quoted in a sketch of Davenport prepared upon the occasion of his death in 1904 by his friend, Charles A. Brinley.

But early Midvale's greatest triumph came on March 18, 1875, when it received an order for gun forgings from the Navy Department's Bureau of Ordnance; this being the first time in the history of the United States Government that such an order had been given to an American manufacturer. The forgings were for little howitzers to be used at coast-guard stations for throwing lines to ships in distress. It was from this small beginning that Midvale's big government business grew. In 1881, when the Navy's Ordnance Bureau invited fifteen American steel manufacturers to submit proposals for forgings for six-inch all-steel guns, Midvale was the only plant that could undertake the work; for it alone had developed a complete system of experimentation and of records.

To Brinley must be awarded the main credit, not only for these triumphs in the technic of steel making, but also for the organization of the working force. By 1882, when he left Midvale, and was succeeded as superintendent by Davenport, he had put practically every operation in the works, down to the handling of coal, upon a piece-work basis.

When he first came to Midvale in 1872, less than a hundred men were employed there. When he resigned ten years later, more than 600 were employed. In 1878 probably about 400 were employed and the works then consisted of five or six dilapidated buildings — a small open-hearth furnace, a hammer or forge shop, a machine shop, a small rolling-mill, a blacksmith shop, and a carpenter and pattern shop. Most persons would have found the place pretty dismal. The buildings generally were so dark that they continuously called for artificial lighting, and this was furnished by kerosene torches that filled the place with a foul odor and shone with a lurid glare amid the smoke they created.

Dismal or not, such was the scene upon which Taylor appeared in his twenty-second year. Foul the atmosphere may have been in the tangible sense; nevertheless, he there found ready created for him in the intangible sense a highly scientific atmosphere, and to this, as he went on at Midvale, he owed much. On the other hand, nothing so vividly bespeaks the swiftness of his progress on the road of science than that he was destined soon to put even far-advanced Midvale in a position to take a bewildering amount of his dust.

CHAPTER III

TAYLOR'S RISE AT MIDVALE

HERE is his own description of his beginning:

> I came then [in 1878] as a laborer because I could not get work at my trade. Work at that time was very dull — it was toward the end of the long period of depression following the panic of 1873. I was assigned to work on the floor of the machine shop. Soon after I went there the clerk of the shop got mixed up in his accounts and they thought he was stealing — I never could quite believe that he was; I thought it was merely a mix up — and they put me in to take his place, simply because I was able to do clerical work.
>
> I did this clerical work all right, although it was distasteful to me, and after having trained another clerk in to do the work of the shop I asked permission of the foreman to work as a machinist. They gave me a job on the lathe because I had made good as a clerk when they needed one, and I worked for some time with the lathe gang.
>
> Shortly after this they wanted a gang boss to take charge of the lathes and they appointed me to this position.[1]

His memory was that he worked as a journeyman machinist not more than two months. Certainly his promotion continued to be of great rapidity — from gang boss to foreman of the machine shop, to master mechanic in charge of repairs and maintenance throughout the works, to chief draftsman, to chief engineer, all within six years. Evidently his later promotions mainly represented the taking on of additional duties, for at all times he remained the operative head of the machine shop.

Entering the employ of the company with no technical education save that represented by his apprenticeships, he had, while he continued to work in the shop ten and more hours a day, to do the studying which qualified him for his promotions.

[1] Testimony in 1912 before Special House Committee.

But the most remarkable part of it is this: in the twelve years he spent at Midvale, or in the years of his young-manhood between the ages of twenty-two and thirty-four, he developed *single-handed* a system of shop management the like of which never had been known before, and despite the opposition his radically new ways were bound to arouse, put the thing into effect with such success that he brought the entire works around to it. And it is to be observed that in these years Midvale steadily increased in size and general importance.

We have seen that one of the two principal owners of Midvale when Taylor went to work there was E. W. Clark, the banker, and that between the Taylor family and this Mr. Clark's family was much social intimacy. Fred Taylor and Mr. Clark's sons were chums. Clarence Clark married Fred Taylor's sister, and these two young men formed the celebrated tennis team of Taylor and Clark, which in 1881 won the doubles championship of the United States at Newport. At the time Fred Taylor went to Midvale, Clarence Clark became an employee of this company's chemical laboratory, and he remained with the company until 1887, at which time he had become the assistant to Russell W. Davenport, the superintendent. The fact is that Clarence Clark and Fred Taylor had great dreams of eventually controlling Midvale, which dreams did not receive their quietus until 1886, when the interest of E. W. Clark in the company was bought by Charles J. Harrah, Sr. And in view of all this, a question may arise as what extent, if any, Taylor owed his success at Midvale to "pull."

He himself freely admitted that in getting started in the world he derived some special advantages from the position to which he had been born. He attributed his early finishing of his apprenticeships to the fact that his parents' means enabled him to work for little or no money. He felt that he could not have persisted in the fight he was destined to make with those Midvale mechanics to get them to increase their production if they could have brought social pressure to bear on him outside the works, and that the management might not have backed him up as it did in this fight if his social position had not supported the belief that he had the interests of the works more at heart than did the men. It may be conceded in general that if his family background had been other than what it was, his character and ability might not have had the chance they did under the Sellers-Clark régime at Midvale to make themselves manifest. When this is said, however, we have about exhausted the story of what he owed to things external to himself.

That no one's social connections could count for anything with Charles J. Harrah, Sr., or with his son, Charles J., Jr., is a proposition to which all who knew them will heartily subscribe.

A product of the Kensington section of North Philadelphia where Cramp's shipyards are situated, the elder Mr. Harrah learned the trade of ship-carpentry at those yards. Later he went to Brazil, where he first was engaged in the shipping trade, and then made a large fortune developing street railways. Upon his return to Philadelphia in 1876 he developed two street railway lines in this his native city, and along about 1886 sold them out. Thus he had the ready cash with which to buy E. W. Clark's interest in Midvale, and at the same time he bought the shares of James A. Wright, which, though few, carried the control. It was his plan to leave William Sellers in his position as president; but, as the common report has it, the Harrahs, father and son, soon came to believe that Sellers was interested too much in his own machine-tool business and not enough in Midvale, and after a few months came a quarrel in consequence of which Sellers summarily was ousted from the management entirely. Harrah, the elder, then became the president, to be succeeded upon his death a year or two later by his son. And though Sellers continued to live until 1905, the Midvale Company never paid a dividend until he died. The Sellers estate eventually profited handsomely from the Harrah management, but not Mr. Sellers himself.[1]

Now, it was in 1884 that Taylor was more or less informally appointed to the position of chief engineer by Davenport, then the superintendent. However, it was not until 1887, or a year after the Harrah reign began, that he was formally elected to this position by the directors. The Harrahs were great jokers, especially Charles, Jr., and they in business might treat themselves to such a good joke as, apparently, they enjoyed at the expense of Mr. Sellers; but as for holding and confirming a man in his job for any reason other than that he *filled* the job — mention it not in Gath.

When you feel you have within you power *plus,* what more natural than to let some of the plus bubble out of you in prank and quip and merry jest? Consider how Napoleon used to pull people's ears! We must believe that the younger Mr. Harrah was a man of power, too. When, as head of the business, he would sit down to luncheon with his department

[1] While the Harrah course in withholding dividends for more than twenty years may have been largely due to the quarrel with Sellers, the Harrahs were by nature remarkably conservative. As soon as Charles J., Sr., took control, he paid up all the company's outstanding indebtedness, and it was the policy of both the Harrahs to cultivate the plant intensively by turning back earnings into equipment. The result was that the comparatively small Midvale Company came to occupy an impregnable position in the trade such as enabled its principal owner to laugh at the efforts of the United States Steel Corporation to bring Midvale into that billion-dollar combination. In 1915, however, financial interests led by William E. Corey made the younger Harrah an offer that he evidently found irresistible; it is said that for the stock that cost his father about $415,000 he received about $9,000,000. After its purchase by the Corey interests, the old Midvale Company became one of several subsidiary concerns controlled by the corporation named the Midvale Steel and Ordnance Company. This latter corporation, or holding company, was organized in the fall of 1915, one year after the World War started, principally to supply munitions to Great Britain, France, and Italy, and it and the Bethlehem Steel Company continued to represent during the war the two leading munition industries of the United States.

chiefs, it was his pleasure to "kid" them one and all. And what Taylor got kidded about was those very same family and social connections of his; industrial Kensington thereby paying its respects to staid Germantown. There, too, is the fact that Taylor had undisguised admiration for the engineering and other ability of William Sellers. True, he was far from approving all of that gentleman's business methods; but he never forgot what he owed to Sellers for teaching him things and enabling him to get started at Midvale, and he would loyally defend him whenever Sellers was attacked. So right along he got it from Harrah about his "Uncle William."

It is reported that when Harrah, several years after Taylor left Midvale, happened to meet him in the lobby of a Philadelphia hotel, the following incident occurred:

"Hello, Taylor, what are you doing now?"

Taylor replied that he was systemizing the Cramp shipyards, and then politely inquired as to how things were going with his former chief.

"Oh," said Mr. Harrah, "I am doing fine. I am making a lot of money. And do you know what I am going to do when I have made a few more millions? I am going to build the finest insane asylum this world has ever known, and you, Taylor, are going to have there an entire floor."

He was indeed a man of infinite jest, of most excellent fancy. But at that there doubtless was some earnest in it. We understand that for many a year Mr. Harrah continued to speak with something like awe of Fred Taylor's readiness to spend his employer's money, and probably he found Taylor's actions in many particulars hard to account for on any rational basis. And yet — well, Harrah let him go ahead and spend the money; he kept him in his position of chief engineer until he, Taylor, was himself ready to leave it; and we shall see that when, later on, wildly-false rumors were circulated about Taylor's work at Midvale, Harrah over his signature paid

Fred Taylor about as handsome a tribute as is possible for the owner of a business to pay an employee.

What was true of the Harrah attitude toward Taylor largely was true of the attitude of all the other Midvale executives. And this from the beginning. The fact is that, whether you were impressed by his family connections or not, the time soon came when you had to consider Fred Taylor for himself alone. His was the kind of a personality that keeps you so busy thinking about it that you scarcely have time to think about any of its related personalities.

His first chief boss at Midvale was Brinley. When Brinley retired in 1882, Taylor, while remaining subordinate to Davenport, the new superintendent, soon came to deal directly, to a large extent, with Sellers, the president. And it can be said of all three of these men that, no more than the Harrahs, were they likely to be considerate of anyone because of his connections, even when they had not such a personality to deal with as that of young Taylor. Those were rugged days. The motive to which management then mainly appealed was fear. And Brinley and Davenport, to say nothing of Sellers, both were first-class exponents of the prevailing school.

Brinley was harsh with you in nice proportion to his liking for you. That was his way of not playing favorites. He was a bit of a martinet. Once when he had fired the foreman of the hammer shop for drunkenness, Guilliaem Aertsen, the assistant superintendent, protested that the man was so valuable that he, Aertsen, could not get along without him.

"Ha!" said Brinley; "have you got any more men too valuable to lose? Give me their names, and I'll get rid of them also. We aren't going to have any men around here we can't afford to do without."

Davenport fully believed in the fine old management principle that to spare the damn is to spoil the man; and as for William Sellers, there was not only one of the greatest engineers of his age, but also one of its grandest disciplinarians. It is said that about the only way you could tell you were making good with Sellers was "when he wasn't ripping you up the back or firing you."

As soon as Taylor came to Midvale it was realized throughout the works that something so unusual had happened that there did not seem to be any precedents by which to judge it. With his spare-ribbed form, frequently sweet smile, and mild blue eye, he appeared quite harmless. Obviously he had gentle instincts. He did no boasting. Yet for one of his years he seemed altogether too self-confident, too cocky. He was a little too interested in everything, and seemed to be lacking in a decent regard for the way his elders did things. A breeze had come into the works, a new force. About it one thing was clear, and that was that, while it evidently was inspired by good intentions, it would need a lot of taming.

But the taming never could be made thorough. That force always was breaking loose in some new spot. It frequently was carried to lengths that seemed absurd. So it became the fashion to laugh at the young man who represented that force, to dismiss many of his actions as those of a crank. His speech truly was extraordinary. His words often came from him so fast that they tumbled all over one another. Sometimes his speech rose to a violence that seemed to classify him as supernormal, if not abnormal. We think he is crazy, we believe he is crazy; but — well, perhaps we would better give him a chance to prove it; that, apparently, was the way they all felt about him again and again.

Of course, we must not here take the word crazy too seriously. Men in steel mills have a boyish habit of passing swift and summary judgments on persons and events. John is all right — or he is a damn fool. Jim is pretty smart — or he is crazy. The language of the mill has no refinements. You may, in a mill, call a man crazy and simply mean that, in certain particulars, he has a way of acting with which you have no sympathy or which you do not understand. We have met more than one acquaintance of Fred Taylor's who did not love him, but none, we believe, who did not respect him, taking him all in all. Many of the present-day executives at Midvale were there in Taylor's time, and they will tell you that, whatever else he was, he was a good " he " man and an altogether honest man.

Yet still there comes — the slightly derisive smile. They still speak of Fred Taylor's " monkey mind " — the mind, you know, that is curious about everything and looks *into* everything.[1] A great deal in their attitude doubtless represents their reaction to all that has been printed about Taylor in connection with Midvale. They want you to understand that when he was there he wasn't the *whole* works. And that is only human. But the truth is that there was no one at Midvale, whether or not he still is connected with that company, who had any notion you could call adequate of what Taylor there was working out.

The nearest to come to it were Davenport and Sellers. Davenport left Midvale in 1888 to go to the Bethlehem Steel Company, and ten years later played some part in bringing Taylor to Bethlehem. Undoubtedly Davenport came to have a lively appreciation of various features of Taylor's management mechanism, but it is safe to say that when he died in 1904 he understood but little of the philosophy underlying this mechanism. No one came to appreciate Taylor's revolutionary

[1] How apposite, in a sense, was this remark about Taylor's " monkey mind," the men who used it little realized. Says James Harvey Robinson in *The Mind in the Making:* " All the higher animals exhibit curiosity under certain circumstances, and it is this impulse which underlies all human science. Moreover, some of the higher animals, especially the apes and monkeys, are much given to fumbling and groping. They are restless, easily bored, and spontaneously experimental. . . . The innate curiosity which man shares with his uncivilized zoological relatives is the native impulse that leads to scientific and philosophical speculation, and the original fumbling of a restless ape has become the ordered experimental investigation of modern times."

work in the metal-cutting field better than William Sellers. It was in the shops of William Sellers & Company that, in 1901 and 1902, these experiments were finished. It is doubtful, however, if Mr. Sellers ever understood all that was involved in Taylor's time study. He could see in 1901 that, to take full advantage of Taylor's metal-cutting discoveries, the management of his shops would have to be reorganized, and he came to have full faith that the Taylor System ultimately would prevail generally. At the same time he never attempted to grip the details of this system.

Carl Barth, who began his employment in Sellers' drafting-room in 1881, tells us that in those days Fred Taylor was laughed at a good deal over at the Sellers plant also. Taylor frequently visited the Sellers drafting room to watch the progress of designs being worked up for Midvale, and whenever he appeared there nearly everyone "took on a smile." This because of his "assertive ways of criticizing and making suggestions." However, a cynic among the young men in that drafting room one day remarked to Barth: "Well, they can laugh at Fred Taylor all they please, but what I notice is that in the end his ideas are acted on."

There indeed it was: By one of the chief men concerned with that company in its early days he was called a crank so often that rage at length drove him to protest in language which one does not ordinarily address to one's senior. He had continually to combat the suspicion that he was not quite normal. It was his rôle to provide innocent merriment for practically all of the men in the management. Yet he not only was steadily promoted, not only was steadily paid a larger and larger salary, but also was permitted to spend big sums of his employer's money in original experiments. Just how he contrived to bring this about should have a great deal of interest, and what we can be sure of in advance is that at the bottom of it all was his scientific realism.

CHAPTER IV

HIS SUCCESS AS A SUBORDINATE

EVEN when he was scarcely in his twenties, he was too shrewd to let his bold spirit of inquiry run away with him. Still, there were certain lessons he had to learn, and as he found these lessons somewhat difficult, they had to be pretty harsh with him.

Apparently he did not learn much from his first chief boss, Brinley. To begin with, Brinley remained at Midvale only four years after Taylor came there, and it was not until the latter part of this period that Taylor really began to get going. Apparently he spent these years mainly in observation and in study. The feeling that he was questioning everything may have been annoying to his elders and superiors, but for the time being he did not cut loose in any radical way, except only as his action in setting out to force his men to increase their production as soon as he became gang boss might be called radical.

"In the early days of the steel industry," he said in his latter years, "there was a very good opportunity for making inventions." All his Yankee ingenuity and his zeal impelled him to take full advantage of this opportunity.

Now, it may be that, despite his scientific bent and his instinctive appreciation of the value of "book learning," he absorbed some of the prejudice against college folk that was general in American industry in his Midvale days. It is certain that though he came to have many highly-esteemed friends and supporters among the professorate here and abroad, he was not a stranger to that subtile antipathy felt by the "practical man" for the "academic." On the other hand, he frequently was confronted by the fact that, at least in this country, such antipathy is likely to be mutual.

> A very serious objection [he testified in 1912] has been made to the use of the word science in this connection [that of management]. I am much amused to find that this objection comes chiefly from the professors of this country. They resent the use of the word science for anything quite so trivial as the ordinary, every-day affairs of life.[1]

Even as broad a scholar as Le Chatelier, professor of chemistry in the Sorbonne, confessed to feeling a trifle of pique when made to realize that the experiments conducted by Taylor amid the every-day work of the shop were more thoroughly scientific than those usually performed in college laboratories. "I was somewhat ashamed to find the science of a practical man infinitely more developed than my own," he wrote to Taylor.

However much in his latter years Taylor may have enjoyed taking little drives at professors as a class, this did not stop him from attempting to get at the exact facts regarding the value of a college education; and it was his mature judgment that for success in life character (that is, "ability to control yourself body and mind" and above all to face the disagreeable) comes first, common sense second, and the intellectual training such as one receives at college, third. As between knowledge of the history and theory of an art and practical experience in it, he estimated that the former counted for twenty-five per cent and the latter for seventy-five. But

[1] Nine years after Taylor made this statement before the Special House Committee, the New York *Evening Post* published a letter from one of its readers which read in part: "A university professor has recently written a very just lamentation over American neglect of the culture of science compared with its cultivation in Germany. . . . Most of the blame belongs to our college and university professors and especially to those in scientific fields. They have long had a superb opportunity to go to the common people and explain the incomparable value of science, but they neglected the duty and disdained the mob."

though knowledge of the history and theory was much the smaller element, it sufficed to tip the scales heavily in favor of its possessor.

This latter fact, apparently, was borne in upon him soon after he went to Midvale. Perhaps he was helped to realize it by the examples of Brinley and Davenport. The remarkable thing about it, however, was the way he set out to get a "scientific education" while carrying on his regular work.

Throughout my early days at Midvale [he said in his autobiographic letter of 1910] I found myself very much short of a scientific education, and began by taking a home study course in mathematics and physics, which was given by the scientific professors at Harvard University. After getting all that I could by correspondence in this way, I then went to the professors at Stevens Institute [at Hoboken, New Jersey], and asked them for proper textbooks, etc., and this started my home study course at Stevens.

About two years and a half after this time, namely, in June, 1883, I graduated as M. E. from Stevens, without, however, having been there except for the purpose of passing all the entrance examinations and finally one after another of the examinations required throughout the course.

You will realize that my time was greatly shortened in getting through Stevens by the fact that I was able to pass in languages — French and German — and in history, etc., right off at the start, owing to my experience abroad and to general reading, etc. So that this left me much less actual work to do than the other boys, and enabled me to get through in two years and a half, while I was at the same time carrying on my duties at Midvale.

It was, among other things, as a "hard-working man" that he came to be commended by the younger Mr. Harrah, and he was not without deserving it. As a part of the day force at Midvale, he worked from 6:30 o'clock to 5:10. Often he volunteered to work on Sundays as well as overtime on week days. And after he had been at Midvale two years he began studying about three hours every night and on Sundays, and kept this up for two and a half years. His parents' means readily would have permitted him to withdraw from the shop while he got his scientific education; but, having of his own volition embarked on his " pilgrimage " into industry, he could not even momentarily turn aside from it; the more it called for discipline and renunciation, the more of joy he doubtless drew from it, even as the strong rejoice to forsake the fireside and breast the winds of winter.

His one best way of getting in his three hours of home study apparently became the subject of some experimenting. At one time he had an idea he could do his best studying in the wee, small hours. He would set his alarm-clock for 2 A. M., at which hour he would rise, bathe, dress himself in his working clothes, and study until 5. Then he would lie down for half-an-hour's sleep, just to brighten himself up for the day's work. At 5:30 he would eat his breakfast and hurry to the Reading Railway station near his Ross Street home, to catch the 6 o'clock train that took him the two miles to the works. During most of his home-study period, however, his study hours appear to have been from about 9 o'clock until midnight, at which mystic hour he would seek to compose himself for sleep by going out for half-an-hour's run. His friend, Wilfred Lewis, tells us that at first this unusual nocturnal activity in the streets of staid old Germantown aroused the grave suspicions of the police, but at length every man on the force got to know that the slender figure there streaking it along was " only Fred Taylor." The neighbors became accustomed to it also. When they would hear a door slam at midnight they would say: " Well, there goes Fred Taylor out for his constitutional." Sometimes he would be seen stopping under a street-lamp to consult a paper or a blank-book; apparently even he who runs may study.

" During these strenuous times," says Mr. Lewis, " I doubt if Taylor ever had more than four or five hours sleep out of the twenty-four, but no doubt his sleep was just as intense and effective as everything else he did." On the face of it, it would indeed seem as if his sleep during this period must have largely made up in quality what it lacked in quantity. His insomnia, we know, was mostly a later development; but whether or not he was comparatively free from his troubled dreams during the years of his home study, he came to feel in his latter years that he had overtaxed himself and was positively opposed to a young man's following any such sleeping régime as he did.

However much he might overdo in any particular, it apparently was to be explained, not by any failure in power of self-restraint, but by an error of judgment. While it is conceivable, for example, that his influence might have been even greater than it was if, on occasions, he had not let himself out so freely in his speech, we have heard of case after case where, going at top speed, so to speak, he suddenly recognized the need of shutting down on himself and did so as with the crack of a whip. He had the will dynamic and static, and also the will inhibitory, which in the economy of mental force corresponds to the part played by the governor in the economy of the steam-engine. The greater the force, the greater of course must be the power of inhibiting or governing it; and when we consider the force that breathed through Taylor, his power of inhibition looms up as remarkable.

Undoubtedly, during his early years at Midvale, he kept himself pretty firmly held in. But that was not the only reason why he did not receive much education from Brinley. Apparently Brinley did not love this young man enough to be really harsh with him. As a matter of fact, Brinley did not come very much in personal contact with any of his men apart from his chief lieutenants. On the other hand, young Taylor took a dislike to Brinley, and the reason for it is both humorous and significant: A gentleman and a scholar, Brinley apparently was more concerned with his scientific work and his problems of management in the abstract than with his men, and we can well believe that his problems in putting the works on a paying basis were many and serious. Nevertheless, it impressed young Taylor that Brinley's aloofness from the rank and file, as well as the little weakness he evidently had for dress, was bad business for a manager. Years afterward, when lecturing at Harvard, Taylor spoke of the fact that it is "necessary for the employer who wants the kindly regard and the respect of his workmen not only not to be a snob, but to carefully avoid the slightest semblance of snobbery," and he went on to say:

> Shortly after serving my apprenticeship, I worked in a shop under the superintendence of a college graduate. His natural carriage led him to hold his head rather high in the air, and he had an imperturbable face. Every day he would walk through the shop, hardly saying anything to any of the workmen. In addition to this, he had the habit of using a silk handkerchief with perfume on it. This was not only disliked, but cordially hated by all the men. They could stand the silk handerchief with perfume, but the corner of the handkerchief which he always left sticking out of the breast pocket of his coat was too much for them, and I must say that I personally cordially shared in their feeling. In later years I discovered that he was a very kindly man.

It was Davenport who first was really harsh with young Taylor, and Taylor always referred to Davenport as his friend. Something of how harsh Davenport was with him, Taylor told in his "Success" lecture. Here he laid great stress on the point that "practically every man engaged in active, useful work, is engaged in serving someone else, and this is equally true of the president of the company and the office boy." It is the duty of every man, Taylor said, to serve his immediate superior. Thus:

Every day, year in and year out, each man should ask himself, over and over again, two questions. First, " What is the name of the man I am now working for? " and having answered this definitely, then: " What does this man want me to do, right now? " Not, " What ought I to do in the interests of the company that I am working for? " Not, " What are the duties of the position that I am filling? " Not, " What did I agree to do when I came here? " Not, " What should I do for my own best interests? " but, plainly and simply, " What does this man want me to do? "

While this seems exceedingly simple, " most men, if they ever learn it, learn it by having it pounded into them."

Let me tell you how it was pounded into me. I was foreman of a machine shop more than half of the work in which was that of repairing and maintaining the machinery in a large steel works. Of course my chief interest and hope in life was that of doing some great thing for the benefit of the works that I was in. My head was full of wonderful and great projects to simplify the processes, to design new machines, to revolutionize the methods of the whole establishment. It is needless to say that 99 out of 100 of these projects were impracticable, and that very few of them ever came to anything, but I was devoting every minute of my spare time, at home and on Sunday, and entirely too much of my time in the works, to developing these wonderful and great projects.

Now the superintendent of the works, who had been a warm friend of mine for years [Davenport], wanted me to keep all of the machines going with the minimum loss of time, and kept telling me this over and over again. I, however, knew much better than he what was for the interest of the works. I did not daily ask myself, " What does this man want me to do? " but I daily told myself just what I ought to be doing. He stood this as long as he could (which was a great deal longer than he ought to have stood it) and finally came into my office one day and swore at me like a pirate. This had never happened before, and I of course at once made up my mind that I should get right out; wouldn't stand any such treatment. I, however, remembered my early advice [that of his uncle], and waited forty-eight hours before doing anything. By that time I had very greatly cooled off, but for two or three weeks at regular intervals my friend, the superintendent, repeated this process of damning me up and down hill, until he finally beat it into my dumb head that I was there to serve him, and not to work in the interests of the company according to my own ideas, when these conflicted with his.

Further on in this lecture, to illustrate the point that what one's employer wants is results, not reasons, Taylor said:

A workman came up to my house in the middle of the night to tell me that a valve had broken and shut down one of the large departments in the works. I took the earliest train at 6 o'clock down into Philadelphia, hired a carriage and drove all over the city to every dealer who might possibly have the valve on hand, and also to all the establishments that were users of this kind of valve. I failed, however, to find it in Philadelphia. About noon I returned to the works, feeling very well satisfied that I had left no stone unturned in my hunt for the valve. I started to explain to the superintendent just how thoroughly I had done my work, when he turned on me.

"Do you mean to say that you haven't got that valve?"

"Yes, sir."

"Damn you, get out of this and get that valve."

So I went to New York and got the valve.

We have heard of still another case in which Taylor was damned up and down hill by his friend Davenport. Midvale received from the Government a rush order for certain articles to be turned out in the machine shop. Having told Taylor of the need of hurry, Davenport arrived at the works one morning expecting to find the job completed, or the whole gang at work on it at the very least. What he did find on the job was one "hollow-eyed" mechanic, who had been working all night while a clerk took notes of his motions. It was quite true, as Davenport freely admitted, that those time-studies might be of great use later on (and they were), but — well, it is said that as the fur then and there flew, Taylor learned a good lesson in the value of common sense; which he himself came to define as "the ability to decide as to the relative importance of things — the ability to select from among the several possible lines of action which lie before you, the one act which is best, the one act which will yield the largest returns."

Where Davenport left off being harsh with young Taylor, William Sellers apparently began.. Again we quote:

> William Sellers ranked undoubtedly in his time as the most noted engineer in this country. It was my good fortune to work under him for several years. During this time I was badly treated by one of the superintendents who was over me. I stood it for a long time, and then decided to go to Mr. Sellers about it. He listened and agreed with what I told him, and then turned to me, almost laughing, and said:
>
> "Do you know that all this impresses me with the fact that you still are a very young man? Long before you reach my age you will have found that you have to eat a bushel of dirt, and you will go right ahead and eat your dirt until it really seriously interferes with your digestion."

That Sellers was a really great man is in no way better shown than by the fact that he commanded the respect, the admiration and the affection of his subordinates and intimates, even while it was generally recognized that in him Quaker thrift was manifested so excessively as to make him often insensible to the just claims of others. He was a powerfully-built man, with a big, booming voice that he could make as harsh as a calliope. He seemed to grow more handsome with the years, especially as his hair, brows, gracefully-curved mustache, and trim imperial beard became snow-white. His self-confidence was grand. Once during Sellers' reign at Midvale, Aertsen temporarily left the employ of that company to go with a western house manufacturing machine-tools. While still with this western house, Aertsen, back in Philadelphia for a day, dropped in for a brief visit at the office of William Sellers & Company.

"Now, how is this, Mr. Aertsen," said Mr. Sellers, grimly, "that you have set up in opposition to us?"

"Oh," said Aertsen, "I am sure, Mr. Sellers, there is room in the world for us both."

"Well," Mr. Sellers boomed forth, as he attached his signature to a letter, "I always have noticed that there is plenty of room in this world for me."

One of the secrets of Sellers' power is to be read in the fact that never did he leave you in any doubt as to what he did or did not want. Though, as a former employee of his tells us, he could "growl like a lion, kick like a steer, and bawl like a bull," it always was for specific reasons that he did not fail to make understandable; so that while the noise might be terrifying, it was not confusing. A thing for which he was particularly admired by his employees was that, despite the sternness of his character, the tenacity of his purpose, and the grandeur of his belief in himself, he always was accessible to criticism, attentive to argument, and open to conviction. If the apprentice boy could prove he was wrong, Mr. Sellers would freely acknowledge it. Always he was big and brave enough to eat crow; in it he found lots of nourishment, and he was a man who never lost sight of the main issue. By him Taylor was influenced in more ways than one.

Early in his direct dealings with Sellers occurred an incident that Taylor became very fond of relating. Mr. Sellers gave him some drawings representing ideas that he wished worked up. In a day or two young Taylor, very much pleased with himself, returned with an entirely new set of drawings of his own preparation.

"What are these?" asked Mr. Sellers as he started to look them over.

Blithely and enthusiastically, Taylor informed his chief that he had become convinced that his (Sellers') ideas were impracticable, and so he had worked up some of his own.

It was a chilly day in early spring, and a fire was burning in the grate. The distance from Sellers' desk to the fire was not so vast that a person sitting at the desk could not, with a little effort, cast things into the fire. And that is where Taylor's drawings went forthwith.

"The next time," said his chief, "perhaps you won't abandon any of my ideas as impracticable until you bring me the finished drawings and show me just where they are impracticable."

It was a stinging experience to have to say "Yes, sir" to that, and then fold your tents like the Arabs and silently steal away. But that is the principal way we all learn things; and the lesson Taylor drew from this experience was that the proper time for a subordinate to offer suggestions is after he has done what he is told to do, not before. It was a lesson, you might say, that was *burned* into his consciousness, and he in turn became one of its most powerful teachers.

His principle of course was that every organization must have a directing head, some one who embodies the organization's common will or purpose in orders to all the parts. And the success of the organization naturally depends on the readiness of the parts to obey these orders. Should they be in the habit of starting a debate whenever an order reaches them, the organization of course will not get anywhere.

But here, now, is a subordinate who receives an order the carrying out of which he is sure will work injury. Shall he obey the order unquestioningly? From his "Success" lecture we know how young Taylor dealt with a situation like that. Whenever he related an incident in which he played the part of the "goat," he acknowledged that he was it. On the other hand, when he related an incident in which he appeared to advantage, he always referred to himself as some one else. Thus he told of how "a young man" had pleased the president of the company which employed him by showing he could do disagreeable things, and then went on to say:

A few weeks afterward the president [Sellers, of course] sent for him to come to his office, and said:

"I have tried to get the oil out of the cylinders of our steam hammers. I know that you are not in the hammer department. Are you able to keep the oil out of these cylinders?"

"Yes, sir, providing you will give the necessary authority to do it."

The president wrote him a letter, stating that he had authority to discharge anyone who disobeyed the orders of this young man in the matter of keeping oil out of the cylinders, and armed with this letter he returned to the works, and appointed a hammer-man on day shift and one on night shift, for each hammer, part of whose duty it was to see that no oil got into the cylinder of his hammer. He showed him the president's letter and told him that if any oil was found in the cylinder of a steam hammer on his shift he would discharge him, whether he put it there, allowed it to get there, or not. In addition to this, he chained up the various inlets to the cylinder and locked them with heavy padlocks, so as to make it difficult to get at the cylinders to oil them.

Before starting to do this, however, he wrote a letter to the president of the company, telling him he believed it was a mistaken policy to keep the oil out of the cylinders; that it was his personal conviction that the cylinders would cut without oil and be ruined. The president answered that he had a steam engine in one of his other establishments running for some twenty years without any oil in the cylinder, and that he would therefore take the personal responsibility of the matter himself.

About three or four months later the company paid a bill of many thousands of dollars to have the cylinders of its steam hammers rebored. They had almost all cut for lack of oil.

To general rules there nearly always are exceptions, and to be a first-class subordinate one must have the intelligence to recognize the exceptional. It will be seen, however, that while this " young man " was led to question the order he received, his spirit of subordination remained intact. As Taylor added, the young man showed " he could obey orders even if he personally disagreed with the policy."

It would appear also that while at Midvale he learned to discriminate sharply between two kinds of orders.

CHAPTER V

HIS SUCCESS AS A SUBORDINATE (Concluded)

THIS is how he expressed it:

There are two ways of giving orders, and in all cases the young man must use his common-sense and a small amount of brains to decide in which of these two ways the order has been given. The first of these ways is, "Take that chair in your left hand. Carry it over into the corner and lean it against the wall." The second of these ways is, "That chair wants to be put away. Go and do it." Now, when a man tells you precisely and exactly and minutely what he wants you to do, it is because he wants you to do just that, and nothing else. When, however, as is the case in perhaps nine times out of ten, a man gives the second type of order, then he expccts you not only to do what he says, but perhaps do a little better than he says, and in giving the man you are serving a little more than he expects, lies more than in anything else the key to rapid success.

And Taylor went on to say:

Throughout life it is the small, unexpected, unasked-for acts of courtesy and kindness that give especial pleasure. It is the little gift, the small piece of uncalled-for generosity, that charms, makes life worth living — and remember, your employer is no exception to the rest of mankind in his appreciation of this.

Quite a large proportion of young men set out deliberately to do barely enough to satisfy their employer — in fact, many of them would feel happy to do as little as they can and still satisfy their employer. Another set of men propose to do just what their employer wants. They, however, are at all times exceedingly careful to guard their own rights and not to give a single thing in the way of service that they are not paid for. About one man, however, in twenty takes the real, quick road to success. He makes up his mind deliberately that in all cases he will not only give his employer all that he wants, but that he will surprise him with something unexpected, something beyond what his employer has any right to ask or expect, and it is astonishing how fast this line of action leads to success.

Here we see his philosophy of giving. Of course he was too shrewd to give indiscriminately and too practical to keep on giving if the other fellow failed to respond.

There came a time at Midvale when he fell to wondering whether he was getting enough salary for what he was giving. It worried him. He felt that if he permitted his mind to dwell on what he was getting, it would be at the expense of what he could give, and his solution of the difficulty was to devote one hour a week, no more, to considering what his services were worth. By this system, so he told his friends, he doubled his salary in a year.

Most emphatically he refused to keep on giving to what he called a hog — that is, to a person so deformed morally as to refuse to play life's little game of reciprocity. Once there came to him a man who had heard of some of his experiments and was seeking detailed information. Only too happy was Taylor to oblige. But when, after he had given his visitor an hour or more of his time, he asked him some questions about himself, the man proved entirely unresponsive. It was as if he said, "I am here to get information, not to give it." So, with startling suddenness, Taylor shut down on him. Here's your hat, sir — what's your hurry?

He gave of his money. A man working on the roof of a building at Midvale fell off and broke so many of his bones that he lay crippled at home for many weeks. In those days there were no workmen's compensation laws, and this man had a dependent family. Every week regularly Taylor took from his own wages an amount equal to the crippled man's and, while contriving to give the impression that the money came from the company, left it at his home. But he was circumspect in giving money. It often did harm, and at the best it was a cheap service. "The great," says Emerson, "depend on their heart, not on their purse," and what Taylor gave most freely of was himself.

In every case, giving must be reciprocal. But let every man, whether employer or employee, be ready to be the first to start the game. The one who starts it first is in a position to exact giving from the other fellow. And if the other fellow fails, in due season, to respond, then fire the hog, be he your employer or your employee. In every case be ready to give too much rather than too little, and in every case give the other fellow plenty of chance to respond. Be careful, however, not to weaken yourself by your giving; never give so much as to unfit yourself for giving more. This, as we understand it, was the philosophy that Taylor did his best to practice.

If he failed in any particular, it was in that of giving of himself too freely. Again and again he was told, not without some justification, that he was a fool to give so much of himself to others. Still, on the whole, he was nobody's fool, and he practiced his philosophy of giving pretty successfully, especially at Midvale.

We know with what jealousy the employee commonly guards everything pertaining to his position; the idea appearing to be that if he can leave his boss in a hole when he quits his position, nothing will so much prove his worth. All such employees Taylor regarded as dunderheads, if only for the reason that when an employer feels he has a man who is indispensable in a certain position, he is likely to keep him there.

No man [wrote Taylor] should expect promotion until after he has trained his successor to take his place. The writer is quite sure that in his own case, as a young man, no one element was of such assistance to him in obtaining new opportunities as the practice of invariably training another man to fill his position before asking for advancement! [1]

As a further illustration of what he was willing to give at Midvale, we may quote this bit of disguised autobiography:

In an engineering establishment [Midvale, of course] there were ten or fifteen young college men who were all trying to work up into good positions. Among them was one man of no especial ability. He appears to have been endowed, however, with fully the ordinary amount of common-sense. At any rate, he saw an opportunity for advancement which the other young men failed to see.

Most of the departments of the works ran night and day, so that every Saturday night and Sunday urgent repairs were required to keep the place running. Naturally, the work of making these repairs was in no way sought for by these young college fellows. They all had something much more interesting to do on Sunday — either choir practice or lawn tennis or social engagements of some kind. So that the superintendent in charge of repairs had a hard time to get the men he wanted to work hard, and chiefly on Sunday.

One of these young college men, however, went to the repair superintendent, and told him that he didn't mind Sunday work at all — in fact, he rather liked it. He said he had served his apprenticeship as a machinist, and didn't mind being called upon at any time. This was such a new experience to the repair superintendent that he sent for him to come in on the following Sunday. He did so well that he kept him at work practically every Sunday throughout the year, and also quite frequently all of Saturday night, and, contrary to what usually happened, he never had any kicks or complaints from this young man.

All of this man's friends, however, laughed at him and remonstrated with him for being so foolish as to take much more than his share of Sunday work. This was particularly true of the rest of the college fellows. His parents, his social friends, also told him that he was nothing but a fool to work in this way. However, by the end of the year practically every superintendent throughout the estab-

[1] *Shop Management*, p. 123.

lishment wanted this young man in his department, and as a result he was promoted with great rapidity.

If, at the beginning, he worked practically on every Sunday for a year, that was far from true of his other years at Midvale. Wilfred Lewis, in writing about the period when Taylor was studying at night, says:

He was a good sport and very fond of tennis, at which he soon became an adept by utilizing his Sundays and holidays without encroaching upon any of his regular duties. His play, in fact, was so nicely fitted in with his work that one helped the other. At the same time he was quite a social favorite, and did not wholly renounce the demands and pleasures of society while working under heavy pressure.

His custom of playing tennis on Sunday at his Ross Street home at first caused something of a stir in that Germantown neighborhood. Soon, however, it came to be generally accepted; and we can gain a clew as to why it was from what is told us by a gentleman who was one of the younger Germantown boys to be sent for to play tennis at Ross Street when any of the regular players did not appear. At first his mother firmly opposed his playing on Sunday, but after hearing *where* he wished to play, she said: "Well, if Fred Taylor does it, it must be all right."

In speaking of Taylor's work at Midvale, Carl Barth says: "He constantly investigated tools and other small appliances that gave minor trouble or fell short of giving entire satisfaction, and in discovering the cause of their shortcomings, was able to effect highly-desirable improvements. Many of these improvements probably could easily have been made by anyone else who had taken the trouble Taylor did to investigate. The basis of it lay in the fact that it was Taylor's genius to recognize the importance of trifles."

This same disposition to look into little things he manifested on the tennis court. Everyone who had played this game had known for years that a net was likely to wear out first in the middle, where it was subjected to the greatest strain. Simple idea to double the thickness of the mesh in the middle, wasn't it? Apparently, however, Taylor was the first to conceive of it. A little more ingenious was his device for tightening nets; this consisted of a post at either end set in an iron socket that permitted the post to be turned and the net thus stretched taut.

The success that he and Clarence Clark had at doubles was generally attributed to their superior team work. Not by any means must we fail to mention the spoon-shaped racket that Taylor devised and habitually used. All his friends delighted to ridicule this remarkable implement, which derived its spoon shape from a crook in its neck, and wherever he took it, as for example at the Newport tournaments, it caused unbounded merriment. Here again all the ridicule in the world could not budge him. Some of his friends think his unique racket was designed to overcome a defect he had in a none too flexible wrist. His partner, Clarence Clark, tells us that Taylor used this racket mainly to facilitate his making the "Lawford stroke," which, so we are informed, is a sort of overcut that causes the ball to strike the ground on a down-curve and shoot forward in a baffling way.

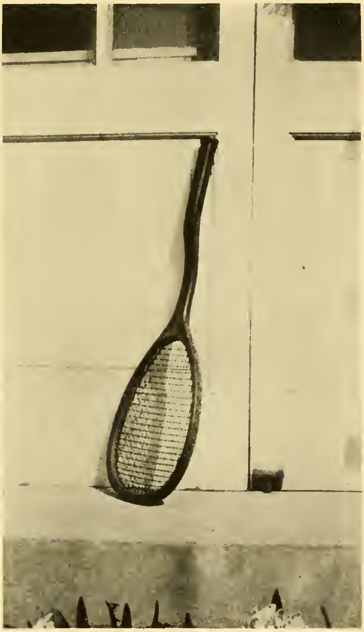
Amanda Montier, who was the waitress in the Taylor household, still remembers the lively dinner parties Fred Taylor would give on Sundays for his tennis friends and others when, in the summer, all the other members of the family were away. Such discussions as would take place at these parties! And yet, says Amanda, what fine young gentlemen they all were!

It was true of Taylor's mature years that no matter where he sat at the table, that place was likely to become the head. And we gather that this was true also of his adolescent years when he was with persons of his own age. "He had," writes

Wilfred Lewis, " a keen wit, sometimes tinged with sarcasm, and was very quick at repartee."

He did not work all summer either. For about twenty years when he was a young man he went camping every summer either in the Adirondacks or in the lake region of Maine. Still, he exerted himself on these trips pretty strenuously also. " As we travelled almost every day," Taylor wrote in 1910, " we were obliged to carry very heavy loads in pack baskets on our backs. My load averaged over eighty pounds, and in some cases was as high as 125 pounds; and I many times carried this load more than eight miles per day over the rough trails in the woods." This despite the fact that he " weighed then only 145 pounds."

His genial, sociable nature also shone forth when the foremen and department heads would gather for luncheon at Midvale. Not only his sociable nature, but also his disputatious. It would appear that wherever he was in those days, there an argument was likely to be also. He was a positive young man. And another positive man at the Midvale luncheons was Guilliaem Aertsen. And as these two looked out upon life from points of view representing about all the difference there is between east and west, their debates were a source of joy to all their sport-loving associates. Neither as boy nor man was Taylor inclined to recognize any degrees in what he considered wrong. If it was wrong to drink, it was wrong to drink a little. If it was wrong to lie, a little lie was as bad as a big one. Once Aertsen asked him if he thought it was wrong to drink coffee. Yes, said Taylor, it was; coffee was a narcotic poison. Was it as wrong, asked Aertsen, to drink coffee as it was to drink whiskey? Yes, said Taylor, it was; he didn't drink coffee. And then the two proceeded to mix it up as to whether, when Aertsen took coffee for his breakfast that morning, he was as much a criminal as a man who gets drunk and murders his wife. Apparently those Midvale arguments



TAYLOR'S SPOON-HANDLE
RACQUET

covered the whole range of the cosmos. It is said that one of the foremen, after listening to Taylor and some of the others holding forth at luncheon one day, was moved to exclaim: "Gee, if I wasn't a Catholic, I'd be like you fellows and not be anything!"

It surely could not be said that Taylor had any morose or misanthropic objections to anyone's enjoying himself. His principle simply was that it is unwise to let your love of pleasure prevent you from taking an extensive view of your duty, and that it is better to make a pleasure of duty than a duty of pleasure. Here is some more disguised autobiography showing the extensive view he took of his duty:

In another establishment [do not let us be deceived; it is still Midvale] a young man, also a college graduate, had worked up to be at the head of one of the departments. A drain which ran underneath the mill became clogged up. He sent his best foreman and a gang of men to clean it out. After they had tried to do it with jointed rods of all kinds, they failed, and reported to him that the only thing to do was to dig down, break open the drain, and clean out the obstruction.

Now this drain was some twenty or thirty feet below the mill, and ran underneath the foundation, which made it extremely difficult to dig, and certainly involved the loss of several days in the operation of the mill. This young man made up his mind that the drain must be cleaned; so he took off all his clothes, put on overalls, tied shoes on to his elbows, shoes on to his knees, and leather pads on to his hips to keep from getting cut in the drain, and then crawled in through the black slime and muck of the drain. Time and again he had to turn his nose up into the arch of the drain to keep from drowning. After about 100 yards, however, he reached the obstruction, pulled it down, and when the water had partly subsided backed out the same way that he had come in. He was covered with slime perhaps half an inch thick, all over, which had to be scraped off with a scraper, and his skin was black for a week or two where the dirt had soaked in. He was of course very much laughed at, and finally the anecdote was told as a good joke at a meeting of the Board of Directors. The president of the company, however, realized that this was just the kind of a joke that his company appreciated.

What, according to Taylor, the young man proved by this thing he did was "first, that he had common sense enough to recognize the fact that his employer wanted him above all things to save money, and second, that he had the grit and pluck required to do disagreeable things." For ourselves we should say he also proved that he had some physical courage.

"It takes but little character to do difficult things if you like them," said Taylor. And this explains the high value he set on sport. It will be remembered that in referring to the outdoor life of Germantown, he said he believed there was nothing finer in the world; sport there being the leading idea, "with education a long way back, second." To his sons, when they went to school, he would say: "I don't know which is the more important, your studies or your athletics." Apparently he felt compelled to acknowledge to them that their studies should come first; but it would appear from his correspondence that he derived far more joy from hearing they had made good on the athletic field than from hearing of any success they might have in the classroom. Sport, in his view, was a developer of that grit and pluck needed to stand the gaff of the disagreeable. If a man did not have this quality, what did it matter how much he might know? Knowledge was not for one's personal satisfaction or adornment, but for use, for service. And how could a man properly utilize what he knew if he had not grit and pluck?

This quality again was needed to enable a man to stand up under the hard knocks of discipline. Perhaps, in his intense way, he rather laid it on as to how he had been "cussed out" by Davenport. At the same time, there can be no doubt that he really was put through a severe course of sprouts by both Davenport and Sellers, and it should be obvious that it was only as he stood up under the drubbing they gave him and so learned the spirit of subordination that he was able to rise at Midvale.

We know, however, that after he had been at Midvale only a few months he began to serve as a manager as well as a subordinate, and so let us see what success he had as a manager.

CHAPTER VI

HIS EXECUTIVE TEMPERAMENT

WE believe it to be a fact that men can be broadly divided into two types: the engineering and the executive. The engineer is the man of science, the executive the man of action. Where did Taylor stand as regards this classification?

> The engineering type of man [says J. E. Otterson [1]] works for the solution of a single technical or engineering problem and is concerned with the determination of the solution rather than the application of that solution to practical activities. The true type has the capacity to concentrate continuously on a single problem until the solution has been reached. He is interested in the determination of cause and effect and of the laws that govern phenomena. He is disposed to be logical, analytical, studious, synthetical and to have an investigating turn of mind. The predominating characteristic that distinguishes him from the executive is his ability to concentrate on one problem to the exclusion of others for a protracted period, to become absorbed in that problem and to free his mind of the cares of other problems. He does not submit readily to the routine performance of a given amount of work. He deals with laws and abstract facts. He works from text books and original sources of information. Such men are Edison, Steinmetz, the Wright Brothers, Curtiss, Bell, Pupine, Fessenden, Browning. These men are the extreme of the engineering type; they have enormous imagination, initiative, constructive powers. Mr. Taylor was in reality an engineer rather than an executive. He applied his wonderful inventive genius to the invention of management methods.

[1] Formerly a naval constructor, and at this writing president of the Winchester Repeating Arms Company. It was while serving in the navy that Mr. Otterson was brought into contact with Taylor and his work.

The executive type takes the conclusions of the engineer and the laws developed by the engineer and applies them to the multitude of practical problems that come before him. His chief characteristic is that he works with a multitude of constantly changing problems at one time. He concentrates on one problem after another in rapid succession. In many instances he has not the time to obtain all of the facts and he must arrive at a conclusion or make a decision based upon partial knowledge. He must rapidly assimilate available facts and fill in what is lacking from the ripeness of his own experience, frequently calling on his powers of judgment, and even of intuition. He is a man of action, boldness, ingenuity, force, determination, aggressiveness, courage, decision; he is possessed with the desire to get things done, impatient of delay. He works from a handbook, a newspaper, or nothing at all. Such men are Schwab, Goethals, Pershing, Farrell, Hindenburg, Hoover.

We frequently find that the leaders of either of these classifications possess something of the qualities of both and therefore we have executive engineers and engineering executives. The combination of a high order of ability in these two classes in a single individual is rare and valuable.[1]

Mr. Otterson is not alone in his disposition to question Taylor's executive ability; the idea that the father of Scientific Management was himself a poor manager is indeed widely held, and it apparently owes much of its vogue to the fact that Taylor himself was in the habit of speaking slightingly of his ability in this connection.

Undoubtedly he had serious defects as a manager. He was *fundamentally* of the engineering type. He was so much more of an engineer than an executive that when serving as an executive he seemed always in danger of reverting to the pure engineer. Nevertheless, any acquaintance with his life as a whole which is at all thorough must lead to the conclusion that along with his engineering genius went a high order of

[1] Paper printed in The Annals of the American Academy of Political and Social Science, September, 1919.

executive ability. As a large part of this latter ability was not native, but was acquired by sheer force of will, it had a certain instability; at the same time, he showed in many particulars the true executive *instinct*.

He ran true to the engineering type, not only in his instinct to seek or develop original sources of information and in his ability to deal with facts and laws in the abstract and to concentrate on one problem for a protracted period, but also in his love for the peace and quiet of the study or laboratory and his tendency to become worried by the manifold and often clashing activities of the shop.

He began to depart from the engineering type and to approach the executive as it could *not* be said of him that he was more concerned with the solution of a technical problem than with the application of the solution to practical affairs.

In his autobiographic letter of 1910 to a professional associate, he said:

> You will probably realize that with me investigation, or rather invention, is a mental dissipation; that it is a very great amusement, rather than a labor; and that if I followed my personal inclination, I would be very likely to give the greater part of my time to this sort of thing. I realize, however, that no man has the right to do very much of this kind of work. This is, of course, especially true when you are doing it with other people's money, and all through my engineering life I had to keep my conscience in very active service to prevent me from devoting too much time to this end of the business, and not enough to the less interesting but vital end of every-day management and economy.

Here appears the fact that the development of the executive in him was due mainly to his conscience and its outcropping in the form of social consciousness. "All of our inventions," he said, "are meant to contribute to human happiness." Clearly he was of the executive type as he was a productionist; was interested in the actual carrying out of the work; was aggressive and driving; was able to control, direct, guide, lead, and inspire men. And if he was a productionist of the first rank, if his enthusiasm for the scientific method was equalled only by his enthusiasm for output, it all had its origin in his desire to bring more and more wealth into the world that it might be enjoyed by all. That was distinctly *his* solution of our economic ills — stop quarreling over the distribution of wealth, and by all getting together with a heart and a will, so increase production that there will be enough and to spare for all. He could not believe that the poverty which is in the world could be attributed to the robbery of one set of men by another. He must needs believe that the cure of poverty lies not in a re-distribution of wealth, but in an increased production.

Taking his work as a manager at Midvale, we of course must view it in its relation to what was then the general state of things.

Though in the 1870's and 1880's Midvale was far-advanced industrially, the emphasis Taylor there found placed on authority and subordination shows that even in that establishment there continued to exist much of the old order in industry, or that preceding the era of large-scale production. So much was this the case that when, in 1909, Taylor prepared his manuscript for his Harvard lectures he was able to draw the following picture of the old conditions largely from his own observation.

> It was my good fortune [he wrote] to be acquainted with several of the great industrial leaders of the past, and in fact to personally work under two of them. Among the most notable of these great men are John Fritz, Bill Jones, Charles J. Harrah, Sr., and last, almost a connecting link between the management of the past and that of the present, because he was a great manager of both types, William Sellers. During the early days of these men none of the modern schemes had been invented which have for their purpose the

individualizing of workmen and the giving to each of them a personal incentive for doing his best. I refer to such modern inventions as piece work, the payment of premiums, contract work, coöperative schemes, task work, and the differential rate. All of these schemes taken together now count for more in the successful management of men even than the personality of the manager, although a great personality still is important, and always will remain a desirable element in management.

During the days of the old captains of industry, practically all of the men of a given trade were paid the same wages. No special personal incentive was offered to any of them. The greatest difficulty was then found in getting men who were able to do good work. It was not a question of getting work done cheaply, but rather of getting it done at all. It was as a favor that good workmen worked for their employers, not in the least a favor that the employers gave the workmen something to do. And under these conditions the personality of the employer counted perhaps for more than any other element. It was not enough for a manager of men to be able, competent, and well-trained. It was also necessary for him to secure and control his men through his attractive and masterful personality. Through all times and in all ages the great personal leaders of men have had rare gifts which command at the same time *the admiration*, *the love*, *the respect*, and *the fear* of those under them. [Taylor's italics.] Men with this rare combination of qualities are born, not made; hence the saying that the captains of industry are born, not made. The great captains of industry were usually physically large and powerful. They were big-hearted, kindly, humorous, lovable men, democratic, truly fond of their workmen, and yet courageous, brainy and shrewd; with not the slightest vestige of anything soft or sentimental about them. Ready at any minute to damn up and down hill the men who needed it, or to lay violent hands on any workmen who defied them, and throw them over the fence, they were men who would not hesitate to joke with the apprentice boy one minute and give him a spanking the next. Such men would be recognized in any age and in any country as real men, fit to be the leaders of other men.

Plainly Taylor admired these men, and those we admire we are likely to emulate. It is certain that, using those "old captains" as models, particularly Sellers, and calling on his gift for the histrionic, he, as soon as he became gang boss, dramatized himself as a person of a quite frightful sort. It was of concern to him that his own physique was comparatively slight. He often expressed the wish that he were at least six feet tall and bulked more impressively. It would seem, however, that he became even more of a "holy terror" than the "large and powerful" men he sought to emulate, so that we here have a fine illustration of the principle that what counts is not so much what you've got as your disposition to go as far as you can with what you've got. Though it may appear that his course here was not without some admixture of folly, we may be sure he did not adopt it because he thought it was pretty. It was due to his observation of what men like Sellers accomplished by instilling fear.

It should be clear also from what he wrote that the old-time captains he so warmly admired were not exponents of just plain brutal force. If they spanked an apprentice or threw a workman over the fence, it was all done in the spirit of Dr. Samuel Johnson's teacher, who always said when he thrashed one of his pupils, "This I do to save you from the gallows." And here we come to something highly important, to appreciate which we must have some insight into what was the essence of the labor problem which grew up coincidently with the development of large-scale production.

Previous to this era which was brought about by more powerful and more complex machinery, factories were mostly workman-owned, or were personally conducted by their employers. Large-scale production, however, made necessary the raising of capital on a correspondingly large scale, or on a scale so large as to require the pooling of individual resources. And that ushered in the evils of absentee ownership.

The owners of the business became separated in space, and still more in spirit, from the rank and file of the employees. They knew they had put their money into the business to get money back, and that is about all they could think of in connection with the business. Out of this came a class of overseers or managers — men who knew they would be held responsible for only one thing; namely, the making of money. And out of this arose a feeling of irresponsibility as far as any human relations inside the business were concerned. The owners did not feel any responsibility for the human beings who worked there; they had employed managers to look after all that. On the other hand, the managers did not feel any responsibility for the workers, because, you see, they were acting only as the agents of the owners. And of course this became worse as the business became larger. As more and more workers were aggregated in a factory, more and more sub-overseers or sub-managers had to be employed, so that the physical and spiritual gap between employer and employees steadily widened.

On top of this the need of large-scale capitalization developed a special class of financiers — men who specialized in the problems of directing capital into paying channels; men who acted as agents for owners of capital, with the result of further increasing the need of getting money out of the business almost at any cost.

Lack of contact between owner and worker, between employer and employee, complicated in this country by the immigration of millions of men alien to our institutions and language — this indeed explains the rise of the labor problem that already had taken definite shape when Taylor began his industrial career in the 1870's.

Now, it is clear that, whatever their limitations, those best representatives of the old school of management were free from the deadly sin of spiritual aloofness from the mass.

Products of the days when most factories were owned and personally conducted by workmen come up from the ranks, they were not conscious of any essential difference between their own clay and that of their men. They jollied their men and joked with them; bawled them out and beat them up in man to man fashion; dealt with them, no matter how roughly or savagely, on a plane of simple human relations, of perfect social equality.

Undoubtedly it was the human spirit in which those old-timers carried everything off that so attracted Taylor. Not only did this spirit appeal to his democratic instincts, but he was keen to observe what it accomplished in practical results; and his course in clinging to it in the new era which had begun to develop at the time of his appearance in industry must be regarded as illustrative of the perfection with which he manifested the evolutionary principle, or that of holding fast to what is good even while things are changed that can be changed for the better.

It was under Brinley that he was promoted first to be boss of the lathe hands and then to be foreman of the entire shop; and in a memorandum prepared for us by Mr. Brinley we read: "Taylor was not as tactful as some men, and did not show a marked ability at that time to keep on good terms with the men in the shop."

We should say that Mr. Brinley's disposition here was to *state* the thing tactfully. As in setting out to be a terror Taylor simulated what was far from natural to him, it perhaps was inevitable that he should overdo it. These, moreover, were the jubilee days of his youth, the days when he rejoiced in his strength as does the young lion.

If his frightfulness was calculated, was entirely put on, it was wholly natural to him not to be "as tactful as some men." While in his social relations he had all the tact that naturally springs from a courteous, kindly nature, and while he fully appreciated, at least theoretically, the value of tact in business, he inherited all the Quaker scorn of that sort of thing as it partook of the elements of dissemblance and dissimulation. True, he himself could diplomatically dissemble and dissimulate. Indeed, so intense was his will to get there, so grim was his resolution not to let anything stand in his way, that sometimes he resorted to stratagems and subterfuges so far from guileless as rather to puzzle and pain some of his most devoted followers. But by all that was deepest in his nature he was prompted to speak the truth regardless of its immediate effect, to speak it plainly and, if need be, rudely.

So much was this the fact that for his "lack of tact" he was destined to become widely, and justly, celebrated, as will appear from an incident that occurred when the question of tact came up while he was testifying in 1914 before the Industrial Relations Commission. "Tact?" exclaimed Taylor. "Why, I haven't any!" Then, peering mischievously out at the audience, he fixed his eyes on his time-study expert and devoted admirer, Dwight V. Merrick. "Have I any tact, Mr. Merrick," he directly appealed. And the story is that Merrick came instantly, dutifully, and loyally to the support of his chief with a loud and emphatic "No!"

From all this we may gather that while Taylor might practice diplomatic methods, he was extremely restive under them. His patience with anyone's vanity or self-love was quickly exhausted, and his attempts to coax or cajole were subject to sudden cessations. If his sagacity was such that it would be doing him a gross injustice to call him bull-headed, he nevertheless scorned to overcome opposition by stealing around its flank — it was his instinct to drive straight through an obstacle, to hit the line in the centre and hit it hard.

CHAPTER VII

HIS FIGHT WITH HIS MEN

IT will be remembered that soon after he came to Midvale he was made clerk of the machine shop. In this position, says Brinley, "his duty was to keep the time records and watch the work of the men." That he watched their work as work never had been watched before, we may easily imagine. He watched it from the viewpoint of the machine time as well as of the handling time; but what chiefly interested him was the fact that, though practically all the work was done on the piece-work basis established by Brinley, the shop was turning out only about a third of what it was capable. That it did not astonish him will appear from this extract from his testimony before the Special House Committee:

> The Chairman. But you were there long enough and worked with them long enough to feel that the workmen were soldiering?
>
> Mr. Taylor. I absolutely knew it. I saw the same thing, Mr. Chairman, all through my apprenticeship, from the time I started as an apprentice until I got through; the thing was practically universal in the shop.

Knowing the reason for this soldiering, and being a good sport, he played the game with the other workmen when he became a lathe hand. He said on the witness stand that perhaps he did a little more work than the others, adding: "But it was not enough to cause my brother workmen to feel that I was breaking rates and making a hog of myself, as they would put it." No sooner did he become gang boss, however, than he started right in to break the soldiering up.

To appreciate the full significance of his action we must realize that, as represented by Brinley, management already had begun to manifest aloofness from the workmen. In all likelihood Brinley felt that the best he could do for the workmen was to set piece-rates that would give them a proper incentive to deliver a fair day's work, and that the rest was mainly up to them. The evidence is that if at Midvale the old idea of authority and subordination still prevailed, the thing was confined principally to men in the management. The workmen had become a separate and distinct class. They were thought of almost entirely as a mass.

We know, however, that from the beginning young Taylor could not see workmen that way at all. He had the liveliest interest in them as individual human beings, if only because their viewpoint, their speech, their culture represented a novelty for his inquiring mind to explore. It became a point of pride with him that he understood them and had good friends among them.

The fact is, indeed, that he deliberately adopted in his youth much of the culture of working people and in consequence revolted, some may think to an extreme extent, against what passes for culture with the rest of us. And it was a permanent revolt. Most of the things that are commonly regarded as the accomplishments of a young gentleman and a young lady he continued to view with contempt. Even such things as a young girl's "coming-out" party became to him "ridiculous nonsense" and again "horrible nonsense." He could not conceive that a young woman had finish just because she could gracefully receive her guests and gracefully be a guest, gracefully wear her clothes, and gracefully dance and sing and play and chatter about Art. If she scorned the toil that fed her and enabled her to sleep warm, then, in his opinion, she, so far from having finished her education, had not even begun.

Something of what the culture of working people is may be gathered when we reflect that the charm they have at their best seems to be that of the plain and simple, the downright honest, the unaffected, the unpretentious. That Taylor became infected with all the workman's typical abomination for everything savoring of "putting on lugs," there can be no doubt; and it is extremely likely that when he would let fall a few "cuss" words in "polite society," it often was his sprightly way of protesting against over-refinement and effeminacy.

His friend, B. Preston Clark, a Boston financier, tells us that Taylor seemed to feel instinctively that his contact with working people brought him strength; and in this connection Mr. Clark points to the fable of Hercules and Antaeus, the son of Terra, the Earth. Antaeus, you will remember, could not be slain as long as he remained in contact with his mother Earth. Again and again Hercules threw him, only to find that he rose with renewed strength from every fall, and it was not until Hercules lifted him *up in the air* that he could strangle him.

What in later years was called Taylor's "tactless and cold-blooded" references to workmen got badly on the nerves of many good friends of his cause. Some cold-bloodedness or impersonality is, of course, strictly necessary in an engineer. He must view labor *both* as a commodity and as a soul; which is to say that sometimes he must view labor with his head, and sometimes with his heart. If all head means shortsightedness, all heart means pure sentimentality. And such was Taylor that when he concentrated for the time being on one aspect of the matter, it not only *was* a concentration, but also was likely to be an outspoken deliverance. However, the references complained of are mostly to be attributed to the fact that he simply could not think of workmen as a race of monsters to be constantly conciliated, nor as a special class of unfortunates to be spoken of tenderly as one speaks of the sick or the insane, nor yet as members of a solid, impeccable, sacrosanct class. He remained incorrigible in thinking of them as individual human beings to be respected and applauded as they had human virtues and reproved and disciplined as they had human vices.

Even so at Midvale he could not help but feel that as the workmen were fully as human as the men in the management, they should be subjected to the same rule, and that therefore it was for him to break their soldiering up.

Though he held back with the rest of the men while working on his lathe, it is highly probable that, with his "lack of tact," he made no bones of letting them know how abhorrent this practice was to him. It appears, at all events, that the men realized very well what he was likely to do when he received authority over them.

As soon as I became gang boss [he told the Special House Committee] the men who were working under me and who, of course, knew that I was onto the whole game of soldiering or deliberately restricting output, came to me at once and said, "Now, Fred, you are not going to be a damn piecework hog, are you?" I said, "If you fellows mean you are afraid I am going to try to get a larger output from these lathes," I said, "Yes; I do propose to get more out." I said, "You must remember I have been square with you fellows up to now and worked with you. I have not broken a single rate; I have been on your side of the fence. But now I have accepted a job under the management of this company and I am on the other side of the fence, and I will tell you perfectly frankly that I am going to try to get a bigger output from those lathes." They answered, "Then, you are going to be a damned hog."

I said, "Well, if you fellows put it that way, all right." They said, "We warn you, Fred, if you try to bust any of these rates we will have you over the fence in six weeks." I said, "That is all right; I will tell you fellows again frankly that I propose to try to get a bigger output off these machines."

Now [continued Taylor] that was the beginning of a piecework fight which lasted for nearly three years, as I remember it — two or three years — in which I was doing everything in my power to increase the output of the shop, while the men were absolutely determined that output should not be increased. Any one who has been through such a fight knows and dreads the meanness of it and the bitterness of it. I believe that if I had been an older man — a man of more experience — I should have hardly gone into such a fight as this — deliberately attempting to force the men to do something they did not propose to do.

In telling the story of this fight, Taylor, as was characteristic of him when he got to talking in his pell-mell tempo, probably fell into some exaggeration as well as permitted his dramatic instinct to splash on the color; but this may easily be allowed for, and here is his story just as we find it in the official record:

We fought on the management's side with all of the usual methods, and the workmen fought on their side with all of their usual methods. I began by going to the management and telling them perfectly plainly, even before I accepted the gang boss-ship, what would happen. I said, "Now, these men will show you, and show you conclusively, that, in the first place, I know nothing about my business; and that, in the second place, I am a liar, and you are being fooled, and they will bring any amount of evidence to prove these facts beyond a shadow of a doubt." I said to the management, "The only thing I ask of you, and I must have your firm promise, is that when I say a thing is so you will take my word against the word of any 20 men or any 50 men in the shop." I said, "If you won't do that, I won't lift my finger toward increasing the output of this shop." They agreed to it and stuck to it, although many times they were on the verge of believing I was both incompetent and untruthful.

Now, I think it perhaps desirable to show the way in which that fight was conducted.

I began, of course, by directing some one man to do more work than he had done before, and then I got on the lathe myself and showed him that it could be done. In spite of this, he went ahead and turned out exactly the same old output and refused to adopt better methods or to work quicker until finally I laid him off and got another man in his place. This new man — I could not blame him in the least under the circumstances — turned right around and joined the other fellows and refused to do any more work than the rest. After trying this policy for a while and failing to get any results I said distinctly to the fellows, "Now, I am a mechanic; I am a machinist. I do not want to take the next step, because it will be contrary to what you and I look upon as our interest as machinists, but I will take it if you fellows won't compromise with me and get more work off of these lathes, but I warn you if I have to take this step it will be a durned mean one." I took it.

I hunted up some especially intelligent laborers who were competent men, but who had not had the opportunity of learning a trade, and I deliberately taught these men how to run a lathe and how to work right and fast. Everyone of these laborers promised me, "Now if you will teach me the machinist trade, when I learn to run a lathe I will do a fair day's work," and every solitary man, when I had taught them their trade, one after another turned right around and joined the rest of the fellows and refused to work one bit faster.

That looked as if I were up against a stone wall, and for a time I was up against a stone wall. I did not blame even these laborers in my heart; my sympathy was with them all of the time, but I am telling you the facts as they then existed in the machine shops of this country and, in truth, as they still exist.

When I had trained enough of these laborers so that they could run the lathes, I went to them and said, "Now, you men to whom I have taught a trade are in a totally different position from the machinists who were running these lathes before you came here. Every one of you agreed to do a certain thing for me if I taught you a trade, and now not one of you will keep his word. I did not break my word with you, but every one of you has broken his word with me. Now, I have not any mercy on you; I have not the slightest hestitation in treating you entirely differently from the machinists." I said, "I know that very heavy social pressure has been put upon you outside the works to keep you from carrying out your agreement with me, and it is very difficult for you to stand out against this pressure, but you ought not to have made your bargain with me if you did not intend to keep your end of it. Now, I am going to cut your rate in two to-morrow and you are going to work for half price from now on. But all you will have to do is to turn out a fair day's work and you can earn better wages than you have been earning."

These men, of course, went to the management, and protested I was a tyrant, and a nigger driver, and for a long time they stood right by the rest of the men in the shop and refused to increase their output a particle. Finally, they all of a sudden gave right in and did a fair day's work.

I want to call your attention, gentlemen, to the bitterness that was stirred up in this fight before the men finally gave in, to the meanness of it, and the contemptible conditions that existed under the old piece-work system, and to show you what it leads to. In this contest, after my first fighting blood which was stirred up through strenuous opposition had subsided, I did not have any bitterness against any particular man or men. My anger and hard feelings were stirred up against the system; not against the men. Practically all of those men were my friends, and many of them are still my friends. As soon as I began to be successful in forcing the men to do a fair day's work, they played what is usually the winning card. I knew that it was coming. I had predicted to the owners of the company what would happen when we began to win, and had warned them that they must stand by me; so that I had the backing of the company in taking effective steps to checkmate the final move of the men. Every time I broke a rate or forced one of the new men whom I had trained to work at a reasonable and proper speed, some one of the machinists would deliberately break some part of his machine as an object lesson to demonstrate to the management that a fool foreman was driving the men to overload their machines until they broke. Almost every day ingenious accidents were planned, and these happened to machines in different parts of the shop, and were, of course, always laid to the fool foreman who was driving the men and the machines beyond their proper limit.

Fortunately, I had told the management in advance that this would happen, so they backed me up fully. When they began breaking their machines, I said to the men, " All right; from this time on, any accident that happens in this shop, every time you break any part of a machine you will have to pay part of the cost of repairing it or else quit. I don't care if the roof falls in and breaks your machine, you will pay all the same." Every time a man broke anything I fined him and then turned the money over to the mutual benefit association, so that in the end it came back to the men. But I fined them, right or wrong. They could always show every time an accident happened that it was not their fault and that it was an impossible thing for them not to break their machine under the circumstances. Finally, when they found that these tactics did not produce the desired effect on the management, they got sick of being fined, their opposition broke down, and they promised to do a fair day's work.

After that we were good friends, but it took three years of hard fighting to bring this about.

CHAPTER VIII

HIS HOLD UPON HIS MEN

THOUGH hardly a continuous fight, it did amount to a continual series of quarrels, all of which had their origin in his unwearіable purpose to get output. Certainly his dramatization of himself as a holy terror was no cheap theatrical pose; if he indulged in violent outbreaks during which he would indeed exhaust the resources of the English language — and the German, too, since among his men were some of that race — these outbreaks all arose out of a spirit of determination itself so quiet that it could maintain itself year in and year out.[1]

When the material was being gathered for this biography, some men who had served under Taylor in those old days were found still working at Midvale, and the way they all agreed upon one thing about him was impressive. Sooner or later in every conversation this thing was touched upon. "You had to do what he said" — again and again it was put in practically the same words.

The very first thing you had to do at his compulsion was to get a move on yourself, work hard, speed up. That was Fred Taylor all over and all through his life: Get into the game! Work hard! In his early days he undoubtedly went to extremes in his purpose to inject this sporting spirit into industry. One man — not a workman, but of the officer class — has told us: "Taylor himself worked sixteen hours a day, and thought

[1] Says Bernard Shaw: "Every man whose business it is to work on other men, whether as artist, politician, advocate, propagandist, organizer, teacher, or what not, must dramatize himself, and play his part." It really amounts to the standardization of a mental attitude or *style* calculated to be the most effective.

everybody else ought to do the same." Nevertheless, not even in the jubilee days of his youth, was there any cruelty involved in his orders. In the first place it will be seen that the cruelty of telling a man to speed up all depends upon the pace he is taking at the time you give him the order. But the main reason why there was here no cruelty will appear in what he said about machine-shop work when it was suggested to him at the hearings of the Special House Committee that the mechanics at Midvale might have resisted the attempt to get them to do more work because they feared "ultimate exhaustion."

> Well [replied Taylor, and we may imagine him indulging in a grim smile], I never had in mind ultimate exhaustion. I never had such a thing in mind, and I do not think any of us in that shop had any fear of ultimate exhaustion. I never heard anyone talk about it. There was no fear that I ever heard expressed in that shop of anyone being overworked. That was not the fear. Perhaps I could make the matter clearer to you by telling you that in machine work — running machine tools — it is next to impossible to overwork a man. In working on the average machine tool, of necessity the greater part of the day is spent by the man standing at his machine doing nothing except watch the machine work. I think it would be safe in saying that not more than three hours of actual physical work would be the average that any machinist would have to do in running his machine.[1]

Though he must be acquitted of cruelty, it of course was not tactful of him to make his men feel that in him they were up against an inexorable purpose, a great imperative. Hardly is it to be wondered at that they kept appealing over his head to Brinley, and that some of the tougher characters thought that the thing to do was to shoot him. His friends and rel-

[1] With the steady progress of machine-tools as regards greater degrees of automaticity, it might now be possible to overwork a man in a machine shop; but what Taylor said was generally true throughout his days in industry.

atives truly were alarmed, and advised him to abandon his custom of walking home along the railroad tracks. His answer was, "They can shoot and be damned." Not only this, but he let it be known by all and sundry that if anyone jumped on him or hit him, it would be a case of "bite, gouge, and brickbats"; meaning, of course, that he would not take a licking, was not to be stopped by any fighting outside the rules.

Anyway you look at it, it was remarkable; though facing opposition remained his daily lot, and it largely became his settled method to beat it down with direct, frontal attacks — yes, though his tongue could be acidly sarcastic and he did not hesitate to lash with it men whose physical strength presumably could have overwhelmed him in a minute — we have only one unsupported rumor that anyone ever tried to hit him. It is said in explanation that, without his stirring hand or foot, there seemed to emanate from him a force of mesmerizing intensity. It became common to say of him: "That fellow's a regular wild cat; better look out how you mix it up with him." What is certain is that Taylor not only consciously practiced the doctrine that the best way to keep out of trouble is to let the other fellow know how ready you are for it, but also recommended this doctrine to many of the young men who came under his influence. He himself practiced it so extensively and intensively that many people got the idea that fighting was a thing to be enjoyed. All this, however, must be read in connection with the fact that in his latter years, when he had removed himself from first-hand contact with the toil and strife of the mill, his gentler side became permanently uppermost and his whole nature mellowed.

A thing that remained vividly in the memory of all his men who were found still at Midvale was his fearsome fining system. He testified, it will be remembered, that having reason to believe the men were breaking parts of their machines deliberately, he fined them "right or wrong." In one case he began by fining a man two dollars, and then, as the man continued to break parts of the machine, doubled the fine each time. Thus it became a question of who would hang out the longer. It was Taylor who did; for when the fine had risen to sixty-four dollars, the man owned up that the breakage all along had been deliberate and said he had had enough. Another man was fined for having a scratch on his machine, and when he protested that he was not responsible for the scratch was told that then he was fined for not reporting it. Fines were inflicted not only for damage to machines, tools, work, or other property of the company, but also for violation of the rules such as reporting late or leaving without permission.

"When Taylor established his fining system at Midvale," says Carl G. Barth, "he was in a life and death struggle with the employees, under industrial conditions totally different from those now existing." Writing in 1903 about the principle of fining, Taylor said:

> Every cent of the fines imposed should in some form be returned to the workmen. If any part of the fines is retained by the company, it is next to impossible to keep the workmen from believing that at least a part of the motive in fining them is to make money out of them. . . .
>
> In many cases the writer has first formed a mutual beneficial association among the employees, to which all the men as well as the company contribute. . . . All of the fines can then be turned over each week to this association and so find their way directly back to the men.[1]

This is what he did at Midvale, and with a fining system made less rigorous as that "life and death struggle" passed, it remained a permanent feature of that management.[2] In-

[1] *Shop Management*, p. 198.

[2] A man who served in the ranks at Midvale several years after Taylor left there writes us: "The beneficial association established by Taylor was an agency of great good. I recall an occasion when I was injured and laid

cidentally it may be said that Taylor did not establish a fining system at any of the plants with which he was later connected, although there is no evidence that he ever abandoned his belief in the principle of such a system as it was administered at Midvale.

Now, whatever Taylor's excesses may have been, there can be no doubt that on the whole he had brilliant success as a manager. In the midst of his violent and repeated quarrels with his men, Brinley promoted him from gang boss to foreman. From the beginning he got results for the management both in more work and better work. But how was it, it may be asked, from the viewpoint of the workmen?

If the men who were of Midvale's management in Taylor's time were found disposed to accompany their words of respect for his achievements with something of a dubious nature, the fact is that when the writer talked with men who were of the rank and file, he found that in every case they expressed for Fred Taylor admiration and affection running on into reverence and worship. The humbler the man, so it seemed, the greater the worship.

They had had to do what he said. But in telling you this they smiled as one does when thinking of some endearing trait of a friend departed. He had made them hot, but now they laughed over it. In one case, right on the marble-top table in the little parlor was a framed photograph of Fred Taylor

---

up for about ten days, that without it I should have been in rather an uncomfortable position. While I think I only drew on it on this one occasion, I know that the sum I received was several times the total of fines which I paid. Usually the fines were quite small. Ten or fifteen cents was the most common amount, although I recall one case where a man smashed up a large machine and damaged an expensive forging on account of having been asleep on the night turn, and his fine was $5. Another case I recall was a $10 fine imposed by Mr. Charles J. Harrah on a nephew of his who had a habit of sneaking out the back way and going to ball games — one afternoon his Uncle Charlie caught him. The fines were distributed by the Time Clerk and were commonly known as "canaries," being written on a yellow slip; and their real effectiveness resulted from the kidding the recipient got from his fellows when a canary was delivered to him."

as he was in those old days more than a quarter of a century before. In another case, the photograph was exhibited among the others in the family's old-fashioned plush album. In still another case, the man excused himself, went upstairs, and returning with the photograph, eagerly exclaimed: "There he is! — that's just what he looked like!"

Perhaps this phenomenon is to be explained by the mysterious factor of personality, or that which enables one man to "get away with" what in another man would very likely lead to his being hanged. While it may be impossible to define a magnetic personality, we know that for the making of it one element is indispensable; namely, enthusiasm; and we take it that, especially in his early Midvale days, one hardly could see Fred Taylor approaching without a tendency to exclaim: "Hail to thee, blithe spirit!"

Among the present executives of the Baldwin Locomotive Works is a man who used to be one of a group of young fellows who, with Taylor, were regular passengers on the 6 A.M. Reading train from Germantown. "Fred Taylor," says this gentleman, "used to tell us on the train about his work at Midvale. Whether or not you took any stock in his ideas, you had to take an interest in him. You liked to see him coming in your direction. He had a trim form and a finely-shaped head. His every motion was brisk and alert. His smile was the most engaging thing you ever saw. And after all these years I can still see the twinkle and sparkle in those blue eyes of his. But the thing that won you most was his enthusiasm; even if you didn't understand what it was all about, you went on your way after you parted from him with new zest and courage for your own work."

Napoleon, we believe, was a great admirer of 2-o'clock-in-the-morning courage, and alongside of it, as a worthy companion, he might have placed 6-o'clock-in-the-morning enthusiasm. But take enthusiasm at any hour! Is it not indeed true that here is the real allegory of the fable of Orpheus, the magic musician who moved stones and charmed brutes? Consider what enthusiasm is. "Against the hindrance of the world," it has been said, "nothing great and good can be carried without a certain fervor, intensity, and vehemence; these joined with faith, courage, and hopefulness make enthusiasm." The root is in the Greek word *theos*, god.

Still at Midvale, that mighty workshop of Vulcan, is heard the echoes of Fred Taylor's wondrous enthusiasm. When he was there, he combed all of Philadelphia for good men to come and work with him. Frequently he would meet these men on Sundays. Some of the men who now are officering Midvale were brought there in this way. And they will tell you how at these meetings Fred Taylor put a spell on them; how they were magically persuaded by him to drop the work they were doing and follow him; how, to use the words of one of these men, they were led by him to believe that "Midvale must be a regular little mechanical heaven."

"Fred Taylor not a good manager!" exclaimed the head of one of present-day Midvale's great operating departments. "That is one of the most ridiculous things I have ever heard. Why, that boy as a manager simply was a wonder. He had a marvelous flow of language. He couldn't talk fast enough to get the ideas out of his head. And the way he adapted his talk to the intelligence of the men he was addressing was nothing short of exquisite. If a man had only a spark of pride, Fred Taylor would fan it into a roaring fire. Why, he would have filled up a corpse with enthusiasm, if only the corpse could hear!"

Of course he had to have something more than enthusiasm to gain the hold he did upon his men. When Brinley referred to Taylor's lack of tact, he immediately added: "On the other hand, his intelligence, honesty and courage won the men's respect."

In the midst of telling us about that fining system, one of Taylor's old men suddenly broke out laughing. "Say, do you know what that bugger used to do? Why — why, he used to fine himself!" Doubtless owing to his proneness to become absorbed in his intellect, the father of Scientific Management was personally quite careless about leaving things around. In his home it usually was left to others to enforce order in his study and among his general belongings. And often at Midvale he would leave a tool where he had been using it. Did he do so? Well, slap on himself went a fine. And he fined himself also whenever he accidentally damaged company property or an order of his as faithfully carried out by a subordinate resulted in damage. This spectacle of his fining himself provided amusement for the entire establishment; but it was an early example of his principle of one law for all, high and low, and the lesson of it was not lost.

All through his life he had a habit of not keeping his engagements on time. It was the one particular in which he seemed to be markedly inconsiderate of others, and it naturally impressed his friends as a strange trait in one who stood as he did for system; but here again he often was as forgetful as an absent-minded professor. A man looking for a job at Midvale was told by him to come back on a certain morning at 6:30. The man arrived at the appointed hour, to find that Taylor had been called from his office to a conference, and it was 11 o'clock before any Taylor appeared. Having forgotten all about the appointment, he had gone from the conference to some other place. He now examined the applicant, took him on, and then said: "By the way, your time starts from 6:30." A simple incident, but the rumor of it spread throughout the works.

For the way he gained prestige among his men by his practical ability this incident may speak: After he had been placed in charge of the general repairs, he wished to have an old building repainted, and sent for a man from outside. Learning the painter's figure, he promptly vetoed it, and named a figure so much lower that the painter exclaimed: "Aw, you don't want a man to make a living!" So then Taylor asked him how he valued his time. The painter said at so much per day. Well, how many days would it take him to do the work? And the painter named the number of days that in his judgment would be necessary. Nonsense, said Taylor, and named a much less number. Smiling sarcastically, the painter turned to go. But Taylor checked him with the positive statement that the work could be done in the lesser number, and he would prove it if the painter would do exactly what he was told. The fact is that when a similar building had been repainted at Midvale, Taylor had observed both the time utilized and the time wasted, and so now had an approximate idea of how long it *should* take. To Taylor's wondrous power of talking people into doing things, the painter finally succumbed. He proceeded to do the job as he was directed; conserving all his effort for the things that were strictly necessary, and working briskly throughout. And when he had finished, he found that though he got from the Midvale Company a sum much less than he had figured on getting, he earned more *per day* then he ever had earned before.

Here was one of the earliest applications of the general principle of Taylor's time and motion study; and it will be seen that at one and the same time the Midvale management saved money and the Midvale employee earned more money. Incidentally the question may arise as to whether the painter felt better at the end of the day when he was working in his slack, haphazard way or when he was working in the brisk, systematic way that Taylor taught him. Which way of working had the more favorable reaction upon his character? What we know is that this painter went around saying of Taylor: "You can't fool that fellow; he knows what he is talking about."

From Sellers, Taylor learned the little trick of not confusing a subordinate by telling him he was doing something wrong. At all events, he never said, " That is not the way to do it," unless he could add, " This *is* the way." At first it was jarring to an old hand to have young Taylor say, " Let me show you how to do that." And it was aggravating not to be permitted to argue the matter. " No back talk now," Taylor would say; " go ahead and do it." It was aggravating, but sooner or later there was likely to appear a reason.

The long quarrel he had with his men taught him the lesson that it is not feasible to force men to do what they regard as clearly against their interests, and we may believe that his overacting of his role of high and mighty ruler largely was confined to the period when he was learning this lesson. Nevertheless, the management methods he came to devise in consequence of his fight with his men were so new and strange that he *had* to go on acting imperiously to get them adopted. He became a great believer in object-lessons, and he always was in a hurry to set up those object-lessons that would demonstrate to his men the benefit to them of his methods. In the meantime he explained to them as best he could; but there can be no possible doubt whatever that if he had relied solely on explanation, he, a pale, gibbering ghost, would have been down there at Midvale explaining yet.

Says Henry L. Gantt, who came to Midvale in 1887: "If Mr. Taylor's actions were largely incomprehensible to those around him, it was because he always acted in accordance with the fundamental reasons of things." Confronted by the fact that the alternative to abandoning the attempt to get his methods practiced was to go right ahead and bring them to pass by " hook or crook," as he called it, he courageously chose this alternative and unwaveringly stuck to his course despite the laughter of his fellows in the management and the continual questioning and balking of the rank and file.

To this day it continues to be charged against him by those who had little or no personal contact with him that at best he acted on the principle that workmen are to be considered but not consulted and that in the main he was of the "benevolent despot" type. Those who think he could have consulted workmen to a greater extent than he actually did utterly fail to realize, it seems to us, that all such methods as his had during his days in industry a fearsome novelty they are far from possessing in these days of the progressive education and development of working people. This aside, if we understand a despot to be "one who governs according to his own will," then it can be most emphatically asserted that Taylor was not a despot, benevolent or otherwise. If he set up a law which *must* be obeyed, it was the law, not of his own will, but of the *one best way*. Imperious as Caesar, *he was not dogmatic or arbitrary*. He did not pretend to be a lawmaker — only a lawfinder. You had to do what he said, not just because he said it, but because he knew the best way; and you had to take his word for this only for the time being, or until the thing could be proved by its workings. If you could prove that yours was the best way, then he would adopt your way and feel very much obliged to you. Frequently he took humble doses of his own imperious medicine.

It will be understood that we here are referring to what was his *prevailing* course, and do not wish to assert that he did not have his lapses. One thing clear is that the laughter to which he was subjected by his associates and the kicking he encountered from his men could not fail to have an unfortunate effect on one of his zealous and at the same time sociable and sensitive nature. He was not the kind of a reformer who gets pleasure out of being in opposition; it worried him far more than it should; and for this very reason he became unduly anticipative of it and a little too quick on the trigger. As one of his men says, he seemed to act on the principle that "he who is not with me is against me," and frequently he made his orders too absolute. Sometimes he would give a man fits for not obeying when the trouble was due, not to the man's unwillingness, but to his failure to understand. In dealing with a man who was timid or was new to his ways, he was likely to scare him so badly that the man would say no when he meant to say yes. Apparently, however, he had a way of capitalizing even these mistakes — there is testimony from all kinds and conditions of men that there was virtue in the touch of Fred Taylor's hand on your shoulder, and whenever he was made to realize he had been unjust, he would call the victim in and square himself so handsomely that the man would go back to work walking on air.

We should say that Taylor's whole career as a manager illustrates, among other things, the fact that the only absolutely impossible boss is the consistently arbitrary or capricious one; that in a boss men can put up with almost no end of bluntness, brusqueness, or curtness, provided only they can see, or he can instill in them faith, that for what he does there is, in the main, *a reason.* A thing that markedly helped Taylor in this connection was the way he accepted responsibility. "I never saw a man who had a greater courage of his convictions than Mr. Taylor," writes William A. Fannon, one of the high-grade mechanics who served under him at Midvale, "and was more willing to rise or fall by his own actions and not blame any mistakes on other people."

Would you think it likely that mechanics would be impressed by the *purity* of their boss's life? Several of Taylor's old men have mentioned this fact about him. In all his dealings as a manager he was well served by his character in general, and particularly as this made him approachable and accessible. He never feared to meet his men. When they struck him for a raise, he never dodged the issue. He granted the raise, or promised it definitely, or turned the man down on the spot. Decisions of all kinds could be obtained from him forthwith. He never dodged unpleasantness or trouble of any kind. Napoleon at the Tuileries gave strict orders to his secretary that he should never be disturbed when there was good news — only when there was bad. And what Taylor mainly wanted to hear of were the things that were wrong, or were exceptional. He encouraged his men to come to him with their kicks — not in groups, but singly, and at the proper time. He listened attentively, and provided clean-cut answers. Thus, however much he might irritate men, they had a habit of saying: "Well, you know where you stand with the doggone cuss, anyway."

We gather that the basis of Taylor's fearlessness in mingling with his men was the very important fact that he was conscious of cherishing no purpose which did not take account of them. If there is one thing writ large in the history of industry, it is that as soon as a manager sets up a good for himself or his principal that is not also a good for his men, there is bound to be hate in them and fear in him. "Halfness" of dealing being foreign to Taylor's nature in every relation, he was inspired, as a matter of fact, to go to really remarkable lengths in seeking to promote the highest good of his men, and with this end in view, appealing to them in definite, concrete ways.

CHAPTER IX

HIS HOLD UPON HIS MEN (*Concluded*)

HE was one of the first men in industry to set out systematically to combat the drink evil.[1]

In the early days of the Midvale Steel Works [he wrote to a correspondent in 1914] the operatives were practically all imported English workmen and the drinking was excessive. Each day at noon a large wagon, loaded with beer and whisky, drove into the middle of the works, and the men flocked around it like ants. . . .

One of the first necessities which we recognized in the building up and helping our men was the absolute elimination of alcoholism from the works and preventing our men, as far as possible, from drinking to excess when outside the works. We, of course, stopped the bringing of liquor of any kind or beer into the works. In order to prevent many of our men who had the bad habit of drinking heavily at noon from doing so, we were obliged to make a rule compelling them to bring their lunch with them to the steel works and not allowing them to go out at noon time. We then made a rule that any man who got drunk and was ever obliged to stay away from work on this account, or came to work visibly under the effect of liquor, was given two serious warnings and talked to in a most serious way twice for offenses of this sort. For the third offense, we gave the man the choice of either leaving the employ of the company or of entirely giving up drinking for a year. In case of Catholics we had the most hearty coöperation of the church. In most cases we called in the priest who lived near our works, and got him to join us in persuading the workmen to join the Catholic Temperance So-

[1] It is said that as early as these Midvale days of his he predicted the triumph of prohibition, and that it would prevail not so much for moral reasons as economic.

ciety, and instead of spending their evenings in the saloons to spend the time in the living room of the Temperance Society.

In other cases we induced them to sign a pledge for a year, and time and time again, just before the year was up, we went to these men and induced them to sign again for a second and third year.

The result of this was that in a few years drunkenness was practically eliminated.

One of his favorite methods as a manager was this: He would send for a man and say: "I've been watching you." And then, while the man was wondering what he had done, he would add: "Yes, I've been watching you, and I've discovered you are the kind of a man who works just as well when the boss isn't around as when he is. Just for that, I'm going to raise your pay. Now, damn you, keep your mouth shut."

He *singled out* men. No mass treatment. And always he sought to pay more money. "Yes, he fined me half a dollar for not reporting a scratch on my machine," one of his old men told us, "but in that same month he raised my wages twice." The spectacle of a man earning good money and big money was one he gloated over. Phrases that fell trippingly from his lips were "first-class man" and "high-priced man."

Now, strictly speaking, this was the only kind of a workman for whom he had any respect. He never attempted to disguise the fact that he aimed to set tasks by what a first-class man can do; and here, in later years, he had difficulty in making himself understood. As practically all of his talk was of, and apparently all his thought was for, the first-class man, it was wondered what he proposed to do with the second-class man — cast him out? This question was one he and William B. Wilson debated at length at the hearings of the Special House Committee. And the substance of his attitude in this connection will be found in these words:

I believe the only man who does not come under "first-class" as I have defined it, is the man who can work and won't work. I have tried to make it clear that for each type of workman some job can be found at which he is first class, with the exception of those men who are perfectly well able to do the job but won't do it.

That is to say, there are only two reasons why a man ever is second class; either he is doing work for which physically or mentally he is unfitted, or he is unwilling to give of his best. Taylor certainly did not propose to set up a standard for any work that was based on what could be done by a man who was unsuited for that work. On the other hand, he did propose to set up standards that called for the best effort of those who were suited for it; and the man unwilling to give of his best he would indeed consign to the outer darkness.

However, he fully realized the folly of confusing first-class effort with effort that amounts to strain. "It must be distinctly understood," he wrote, "that in referring to the possibilities of a first-class man the writer does not mean what he can do when on a spurt or when he is over-exerting himself, but what a good man [i.e., a man suited for the job] can keep up for a long term of years without injury to his health. It is a pace under which men become happier and thrive."[1]

Perhaps, even as thus explained, there will cling to this Taylor doctrine an impression of hardness, of something relentlessly exacting. The fact is, however, that there is testimony from man after man who worked under Taylor that no matter how much they might resent for the time being what he did *to* them, they eventually had to take off their hats to him on account of what he did *for* them. Here is a letter from Charles W. Shartle, a high-grade mechanic who worked two years at Midvale and now has a business of his own; after telling us how angry he had been made by some of Taylor's harsh and sarcastic remarks and how much he

[1] *Shop Management*, p. 25.

resented Taylor's way of making his orders too absolute, he goes on to say:

Shortly after I started I was given a casting to lay out for drilling, and I made a mistake in laying it out, which I believe was partly due to an imperfect drawing, and I did not know Mr. Taylor very well at that time, and while the casting did not amount to much more than fifteen or twenty dollars, I thought that I had made a terrible mistake, and that it would reflect upon me, and I believed that I would be discharged, and I did not want to leave that way, so I thought the best thing to do was to quit, and if I remember correctly I gathered my tools together and had my overalls rolled up and ready to walk out before I told Mr. Taylor what happened, and I think he gave me a talk which lasted about an hour, and my recollection of that conversation was, that a man who never made a mistake never did anything, and that he felt sure that by making this mistake, I, as well as the company, would be benefited, and that he would expect me to put forth better efforts, not only to be accurate, but to do extra work to make up for this mistake, and with that understanding no fine would be attached, or no one would know of this mistake except he and I. . . .

I do not believe I ever met a man who could get more out of me than Mr. Taylor did. While I did not agree with his ideas of system, I think that the time that I spent with him was of more benefit to me than any other man I ever came in contact with, and I believe if I had stayed with him we would always have gotten along together. And I still further think that my having my own ideas about certain things would have been a benefit to him, because I think that in a good many things he was an extremist. In fact, if he had not been an extremist he would never have accomplished anything like the work he did.

I do not believe any one could ever come in contact with Mr. Taylor without absorbing some of his enthusiasm, and that anyone who came in contact with him once, would not readily forget him. I left Midvale in the spring of 1886, and I never met Mr. Taylor again until about 1905, and then it was just by accident. I was transacting some business at a bank window in Philadelphia, and I heard

Mr. Taylor talking at the window next to me, and it was not necessary for me to see him to recognize him.

While working under Mr. Taylor we worked hard. When he would give us a job he would tell us when he expected it finished, and there was no reason to ask any questions about it, or argue the matter, and it was up to us to finish it, even if we had to work all night to get it done. We used to go off in the early part of the evening to keep an engagement, and then go back to the shop and finish the night to get the job finished.[1]

I suppose boys do this same thing to-day, but I do not know where the boys are. I wish I could find a few to work for me. I suppose it is because I do not drive them to it as Mr. Taylor drove us, or suppose I do not get the enthusiasm into them, or show them the importance of it. But I believe boys to-day are the same as they were then, and I cannot help but believe that we did our work and worked as hard as we did, just because we wanted to please Mr. Taylor.

Among other things, Taylor gave his men vivid lessons in the value of time; but from all we can learn we should say that the main thing he did for them was to cure them of what William James calls *the habit of inferiority to your full self.* Though the man who does this may seem for the moment to be your enemy, time certainly must show that he is your very best friend. This especially when he does his part; and the effort Taylor exacted from the employee must be interpreted in the light of what he exacted from the employer. He held, for example, that the management must find the work for which the employee is best fitted, must help him to become first class in this work, and provide him with all due incentive to give of his best.

Fully to understand his doctrine of the first-class man we also must link it up with his doctrine of *the will to get there.*

[1] Mr. Shartle here refers, of course, not to regular or routine jobs, but to special ones such as resetting machines that had shifted from their foundations and to other repairs and new work calling for haste. It was for these special jobs that mechanics of Shartle's grade were particularly employed.

It was his observation that men differ not so much in brains as in will, in spirit. The will is the man, the spirit is the life. "If a man won't do what is right," said Taylor, "*make* him." It shocked many persons; but here was just another proof of his thoroughness, of his determination to get results from all kinds and conditions of men. His thought-out method was to begin, as it were, *pianissimo e calmato*, and as this failed to get results, call on the "science of profanity" and proceed *crescendo* to *fortissimo e furioso.*

> There is a large class of men [he wrote] who require no discipline in the ordinary acceptance of the term; men who are so sensitive, conscientious and desirous of doing just what is right that a suggestion, a few words of explanation, or at most a brotherly admonition is all that they require. In all cases, therefore, one should begin with every new man by talking to him in the most friendly way, and this should be repeated several times over until it is evident that mild treatment does not produce the desired effect.
>
> Certain men are both thick-skinned and coarse-grained, and these individuals are apt to mistake a mild manner and a kindly way of saying things for timidity or weakness. With such men the severity both of words and manner should be gradually increased until either the desired result has been attained or the possibilities of the English language have been exhausted.[1]

It may be that his *calmato* was likely to leap with bewildering quickness to *furioso;* but the particular point here is that however much he may have overemphasized the use of force and discipline, the object of it never was "nigger-driving," as he called it; never that of lashing men into becoming broken-willed slaves. Coercion, as Felix Adler has said, may be of two kinds: "stimulative and repressive; stimulative to overcome inertia, repressive to subject wrong to right impulses." Mainly of the stimulative type, the coercion by Taylor was repressive only in the sense here specified. It was

[1] *Shop Management*, p. 196.

the very opposite of suppressive. He shocked, stung, and provoked his men with the deliberate purpose of arousing in them their power of will, of bringing their spirit forth. And a very interesting thing about it is that he seems instinctively to have realized that the will cannot act without a purpose, that the purposive will is the only will — that, in fine, all will is the will to get *there,* to attain some object, some goal.

In *Crowds,* by the English essayist Gerald Stanley Lee, we find this statement which may well seem extravagant:

> I think that while Christ would not have understood Frederick Taylor's technique, his tables of figures or foot-tons or logarithms, He would have understood Frederick Taylor.
>
> Nearly all the time that He could be said to have spent in His life in dealing with other men He spent in doing for them on a nobler scale the thing that Frederick Taylor did. He went up to men — hundreds of men a day, that he saw humdrumming along, despising themselves and despising their work and expecting nothing of themselves and nothing of any one else and asked them to put their lives in His hands and let Him show what could be done with them.
>
> This is Frederick Taylor's profession.

Such words do seem extravagant; but, apparently through some power of intuition, Mr. Lee got pretty close to the facts. At Midvale Taylor did go to men he saw "humdrumming along" and give them a vision, a purpose, a goal, such as would enable them to forget the roughness of their path and rise above the hard knocks of discipline.

He seems to have been greatly concerned over the men who regularly did nightwork. A man could not get his proper sleep when working at night. Anyway, a man ought to have a place to go when his work was over where he could properly rest; a place well away from the works where there were no street cars banging by; a place with a little garden; a proper place for his children; a nice little place to which he could retire when his working days were over. All his talks seem to have been homely enough, the Lord knows. But why talk a hundred to men who are at zero? The high is always relative; and we can well believe that Fred Taylor spoke to those men as they never had heard a man speak before. He indeed asked them to place their lives in his hands. Let them follow him. "Do as I tell you," said he, "and you will get there."

He appealed to them to save their money and invest it wisely. He placed great importance on this. He read little lectures on thrift even to the colored folk who served in his parents' home. He wanted to make a capitalist of everybody. And his were not just plain exhortations to save; he was ready to give instructions in the details of saving and investment. It must be admitted that in all respects he talked "old stuff" — the very sort that was preached by that mossy old ruin, Benjamin Franklin. Be sober, honest, diligent, thrifty. Guard your health. Respect your boss. Serve him his way, not yours; for he carries the responsibility. Give and continue to give without being in a hurry about getting. Cast some bread upon the water. Give more than is required of you. Give of your best. Such terribly old stuff, this, that it does seem to hark 'way back to that old-time Carpenter's talk about good and faithful servants and where the Kingdom of Heaven is situated. And has it not struck the reader as curious that, in seeking to get those Midvale workmen to follow him, Fred Taylor spoke so much about *rest?* The principle seems to have been: "Work, for the night is coming."

Among the old Midvale men who love him and those who do not, there is unanimity as to this: that all of his fighting was aboveboard; that it was strictly impersonal, was free from vindictiveness; that as soon as a man got in line the past was forgotten; that all those who did what he told them to do got there as he predicted; that every promise he made was redeemed in full. A man of the officer class who was free in talking about Taylor's "monkey mind" told us almost with the same breath: "When I came here, Taylor said that if I followed a certain course through a term of years I would rise to a certain place, and it came out just as he said." So often were his predictions found to partake of prescience that he came to enjoy at Midvale the reputation of a prophet.

Of course he could not influence every man. If there is nothing so contagious as enthusiasm, there are natures which are from this contagion immune. When fire comes in contact with ice, there is a hissing. And industry has its men who are born morally defective: not only shirkers and loafers who apparently are incurable, but also chronic kickers against all authority.[1] Such men could not breathe the same air as Taylor. Voluntarily or with assistance, they melted from his presence. All through his life he let it be known that he had no use, as he expressed it, for "a bird that can sing and won't sing."

It would seem that he fired men, not only for being unwilling, but also for being too willing, or for going ahead too fast for him. That is to say, if one of his men developed so as to become worthy of a larger opportunity than Midvale could provide for him, he sought to get him a position with another company where his abilities could find fuller scope and he would be paid accordingly. On the witness stand Taylor said that when it became known at Midvale that he was doing this, "Mr. Sellers almost frothed at the mouth." But he continued to advocate this thing on principle; his idea being that what the company might suffer from losing a good man in this way would be more than made up to it in the incentive it would give those who remained.

He had undisguised scorn for the employee who keeps his resignation "hanging up on a peg," ready to take it down

[1] Students of the new psychology will recognize these as "rebellious little boys who have forgotten to grow up."

whenever his feelings are hurt by a rebuke or severe criticism. It was wholly natural that having thrived on discipline himself, he should believe in it for other men, including his workmen.

But perhaps something like this may be said: "Oh, yes, Mr. Sellers and the rest of them put young Taylor through a pretty hard game, and doubtless he stood up under their punishment pretty well. But, after all, they were of his own class — for all their harshness to him he was accepted by them as one of their own kind — and that made it easy for him to take their punishment."

It would appear that right here we have the most fundamental reason why every willing, self-respecting workman with whom Taylor came in contact consented to his rule, austere though it was, and mysterious and disturbing as were many of the things he demanded of them as he sought to get established his new system. Driving them or leading them, shoving them along or pulling them along, arguing with them or appealing to them, swearing to them or apologizing to them, he actually was *one* of them, and they felt it.

A mechanic who long since has risen to a high management position tells us of an occasion when he went to Taylor to complain that he was being unjustly treated and to say he would not stand for it any longer. To his amazement, Taylor suddenly "jumped on" him and used him as a "mop for cleaning up the floor."

"I give you my word," this man said, "that what I took from Mr. Taylor that day I never would have taken from another human being. I was a coward, a damned quitter. I had no guts. I was a little yellow dog. Never before had I heard, much less had directed at me, such a stream of abuse. No; I wouldn't have taken it from another human being."

"Well," it was asked, "why did you take it from him?"

"I don't know, except it was the man's magnetism."

"Are you sure there isn't a better explanation than that?"

He thought it over. "Well," he said, "I suppose the real reason was that I could not help but feel that Mr. Taylor meant it for my own good."

There was calculation in his friendliness as there was in his frightfulness. He had figured out its effectiveness. Nevertheless, it was not affected. He gave full reign to his mischievousness and at the same time was perfectly sincere when in his lecture at "aristocratic" Harvard he said:

> The working man and the college professor have fundamentally the same feelings, the same motives, the same ambitions, the same failings, the same virtues. And a moment's thought must convince any one of the truth of this fact, since the college professors of the present are universally the descendants of the working men of the past, while the descendants of the college professor are sure, in the course of time, to again return to the working classes. We are all of the same clay, and essentially of the same mental as well as physical fibre.

The present day mechanics who served under Taylor followed his later career with intense interest, and you could not help but realize that they viewed his achievements almost as if they had been their own. Their pride in him was immense. They boasted that he had told them he cared more for them than for any of his later men, because, they said, "we were his first pals." It would seem, then, that when you see yourself in the other fellow, he sees himself in you.

Now, among the sarcastic remarks which Taylor used to toss off to his men, the one that caused them to rear and plunge the most will appear in this statement by William A. Fannon: "I often thought Mr. Taylor would have made more rapid progress if he had been more tactful and not so willing to combat in such an intense way anyone who did not agree with him. A remark that always impressed Mr. Shartle and myself was one he sometimes used when we opposed him or discussed a proposition with him. 'You are not supposed to think,' he would say. 'There are other people paid for thinking around here.'" To this Mr. Shartle adds: "I never would admit to Mr. Taylor that I was not allowed to think. We used to have some hot arguments just over that point."

Can you imagine any other manager not merely telling his men this, but actually arguing it out with them! Quite likely the spirit of it was largely in Taylor's mischievous or "kidding" vein; nevertheless, he had in mind something not merely serious but very important; and when we come in our next chapter to deal with his work as a mechanical engineer, we should be able to see just what this was.

CHAPTER X

HIS WORK AS A MECHANICAL ENGINEER

THERE were great opportunities for invention in the steel industry when he went to Midvale. Presently he saw that, to take full advantage of such opportunities, he would have to be grounded in the history and theory of the mechanical art. Hence his study at home of the courses arranged by a first-class institute of technology. He finished this study with his head full of "great and wonderful projects," not only for the designing of machines, but also for the simplification of processes, and the revolutionizing of the methods of the whole establishment. After a while, it was beaten into his head that, however amusing such projects were to him, they were hardly what his employer was looking for. This led him to concentrate his attention on every-day improvements, and here again he had to learn something.

As in his later years he was wont unconventionally to express it in his platform talks to business men, he found that while he always would say to himself, "Well, Freddy, that last invention of yours was probably the greatest thing that ever happened," the vast majority of his first inventions turned out to be "not worth a damn." Analyzing his failures, he found they could generally be attributed to the fact that his inventions were not based on sufficient study of what already had been invented or was in use. He had been inventing *de novo*, had been repeating old errors — at the best had been *re*inventing.

Early in his Midvale days he appeared at William Sellers' machine-building plant with a roughing tool which, just designed by him, he proclaimed with all his wonted enthusiasm.

"Yes," J. Sellers Bancroft, a nephew of the owner, agreed at once, "that is a very good tool."

"How do you know?" asked Fred Taylor suspiciously.

"Well," was the reply, "I think we have been using it here for two years at least."

As the Sellers plant was a regular hive of inventive ingenuity, he was fated to have repeated experiences of this humiliating kind, and the lesson of them may well have largely prompted his action in joining the American Society of Mechanical Engineers. This was in 1886, when he was thirty, and the society was six years old. It is certain that he became a diligent student of the papers presented to this society, and so kept in touch with the best thought in his profession.

Now, when with his magnificent disdain of tact he told his men they were not supposed to think, it undoubtedly had largely to do with the principle he learned from Sellers, that a subordinate should do his best to follow out his instructions before he tries to improve on them. And the probabilities are that this principle was strongly reenforced in his mind by his humiliating experiences with many of his early inventions. What we know is that he derived from these experiences an uncommonly good grip on a principle closely allied to the foregoing; this latter one being that unless or until you are in a position to think to *some purpose,* you would better not try to think at all — that is, not try to think *originally* — but content yourself with the implements and instructions others give you.[1]

As a matter of fact, in Taylor's early distinction between thinking and doing we can see in embryo the idea back of his

[1] We believe that under the new pedagogy students are encouraged to try to work things out for themselves even before they have become familiar with what already is known, this with the idea of an early development of their powers of initiative. We do not understand, however, that anyone yet has made clear how this can be applied in industry where men must coöperate to discharge tasks in the minimum amount of time.

later sweeping segregation of planning from execution, or that which was the basis of the system having for its grand objects scientific standardization and control. This being so, we shall have occasion to deal extensively with this matter again. Here we shall simply introduce what Taylor revealed of his attitude in this connection when the subject came up while he was testifying before the Special House Committee.

"If," said the chairman, "the workman has to obey instructions implicitly as to how the work should be done, would he not thereby simply become an automaton, and would not that ultimately reduce the skill and the value of the skill of the workman?" Taylor's reply incidentally will afford a good example of his sarcastic vein:

Mr. Chairman, I want to give an illustration in answer to that question, because I think my answer can be made very much clearer through an illustration than through a single sentence.

The workmen — those men who come under scientific management — are trained and taught just as the very finest mechanic in the world trains and teaches his pupils or apprentices. Now, I think you will agree with me as to who this finest and highest-class mechanic in the world is. So far as I know there will be no question about him, for we will all agree that the highest-class mechanic in the world is the modern surgeon. He is the man who combines the greatest manual dexterity and skill with the largest amount of intellectual attainment of any trade that I know of — the modern surgeon.

Now, the modern surgeon applied the principles of scientific management to his profession and to the training of the younger surgeons long before I was born — long before the principles of scientific management were ever dreamed of in the ordinary mechanical arts. Let us see how this man trains the young men who come under him. I do not believe that anyone would have an idea that the modern surgeon would say to the young doctors who come into the hospital or who come under him to learn the trade of surgeon — I do not think the surgeon would say anything of this kind: "Now, boys, what I want of all things, is your individuality, your inventiveness."

I do not think that anyone for an instant would dream that a surgeon would say to his young men, for instance: "Now, young men, when we are amputating a leg, for instance, and we come down to the bone, we older surgeons are in the habit of using a saw, and for that purpose we take this particular saw that I am holding before you. We hold it in just this way, and we use it in just this way. But, young man, what we want, of all things, is your initiative. Don't be hampered by any of the prejudices of the older surgeons. What we want is your initiative, your individuality. If you prefer a hatchet or an ax to cut off the bone, why chop away, chop away!" Would this be what the modern surgeon would tell his apprentices? Not on your life! But he says, "Now, young men, we want your initiative; yes. But we want your initiative, your inventive faculty to work upward and not downward, and until you have learned how to use the best implements that have been developed in the surgical art during the last hundred years and which are the evolution of the minds of trained men all over the world; until you have learned how to use every instrument that has been developed through years of evolution and which is now recognized as the best of its kind in the surgical art, we won't allow you to use an iota of ingenuity, an iota of initiative. First learn to use the instruments which have been shown by experience to be the best in the surgical art, and to use them in the exact way we will show you, and then when you have risen up to the highest knowledge in the surgical art, then invent, but, for God's sake, invent upward, not downward. Do not reinvent implements and methods abandoned many years ago."

That is precisely what we say to the workmen who come under scientific management. No set of men under scientific management claims that the evolution has gone on enough years to be in the same high position as is occupied by the surgeon, but they do claim that the 30 years of scientific investigation and study (which goes on under scientific management) of the instruments that are in use in any trade, whatever it may be, have enabled those engaged in this study to collect at least good instruments and good methods, and we ask our workman before he starts kicking: "Try the methods and implements which we give you; we know at least what we believe to be a good method for you to follow; and then after you have tried our way if you think of an implement or method better than ours, for God's sake come and tell us about it, and then we will make an experiment to prove whether your method or ours is the best, and you, as a workman, will be allowed to participate in that experiment. It is not a question of your judgment or my judgment or anyone's judgment; it is a question of actual experiment and time study to see whether this suggestion is better than the standard we have had in the past." And if it proves to be better, what I advocate every time is, not only that the new method shall be adopted, but that the man who made the suggestion be paid a big price for having improved on the old standard.

We do not think of the average surgeon as an automaton, because, even if he does not originate his implements and methods, we know that the proper use of his implements requires a dexterity we cannot possibly associate with a machine, and we know also that the drilling to which he has been subjected to enable him to comprehend the why and wherefore of his methods has made it necessary for him to use his brains. It is a big mistake to think that those who do not think originally do not think at all. Really original thinkers are the *great* exception. The best the vast majority of us can do is to travel after them through the fields they have explored. Many of us cannot even follow instructions efficiently. Managers know that those men are comparatively rare who have sufficient power of concentration quickly to grasp instructions in any way complex. Yet the ability to concentrate at will is the essence of the ability to think. It was Taylor's idea that the ability to follow instructions quickly, alertly, and snappily is a gift having social value fully equal to that of the ability to originate. He of course knew it is more amusing to try to work out things for yourself; but, as will more fully appear later, his position was that while work should be made as *interesting* and even as *pleasurable* as possible, *amusement* and work do not go well together. Work while you work (and make it interesting); then play while you play.

In his "Success" lecture, which, it will be remembered, was addressed to engineering students, he said:

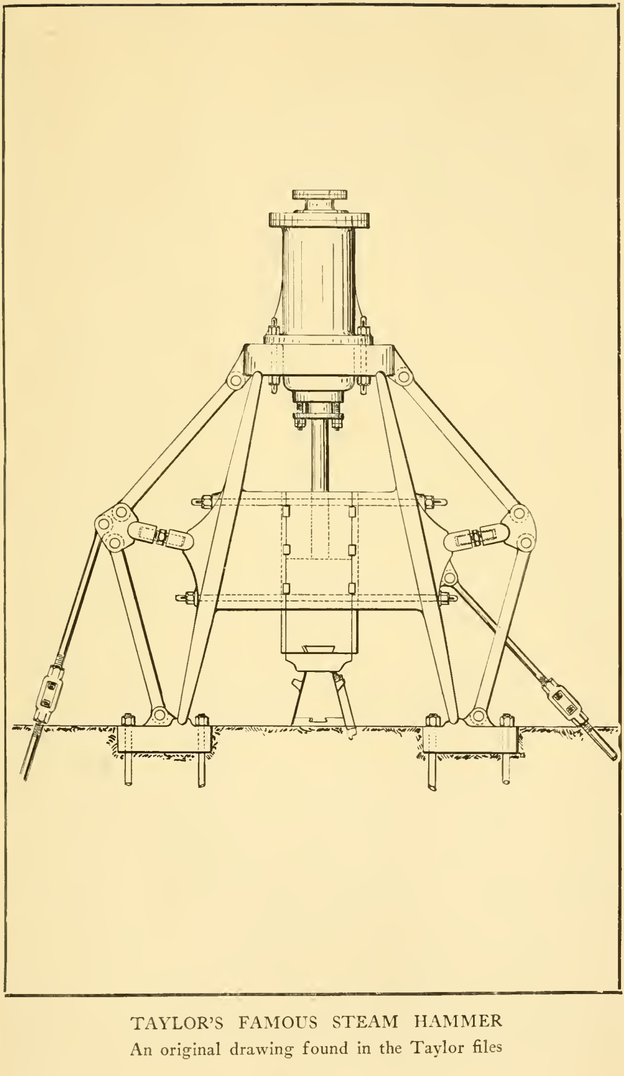
> There is one rock upon which many a bright and ingenious man has stranded. Invention may be properly called almost the dissipation of our profession. Perhaps the greatest temptation to the engineer who loves his profession is that of indulging his inventive faculty. Many of our brightest men practically spend their lives in worrying over the great improvements and inventions which they have in their minds. They squander all of their own and much of their friends' money in trying to make them pay after they have been perfected. Now for the *average* man no invention can be looked upon as a legitimate invention which is not an improvement on mechanism or processes or appliances which are already in existence, and which are successful. It is thoroughly illegitimate for the *average* man to start out to make a radically new machine, or method, or process, new from the bottom up, or to do things most of which have not already been done in the past. Legitimate invention should be always preceded by a complete study of the field to see what other people have already done. Then some one or more defects should be clearly recognized and analyzed, and then it is entirely legitimate for the engineer to use his ingenuity and his inventive faculty in remedying these defects, and in adding his remedy to the existing elements of the machine or the process which have already been found to work well. Any other invention than this should be looked upon as illegitimate, since it is almost sure to waste the money of your employer, as well as your own, and to result in partial, if not complete, disaster. Throughout the manufacturing world there exists a proper and legitimate suspicion and dislike for the man who is forever coming forward with new and radical improvements and inventions.

Here we see that Taylor deprecated most attempts to be original on the part, not only of workmen, but also of engineers. Many attempts to be original are, in fact, due to inordinate egotism; the would-be originator thinks he is too grand a person to follow where others have trod. An egotistic desire to be original, to do great and glorious things, to be revolutionary, is notoriously a weakness of youth. If Taylor himself really came to do great things, it was just because the desire to do them was early knocked out of him. Beginning in the management field with no desire other than that of adding his humble improvement to what had been found good, he followed a strictly evolutionary course throughout; he became revolutionary only in relation to the mass of his contemporaries, and this was due to his superior enterprise and boldness in pursuing the logic of events, or in taking the further steps made necessary by those he already had taken.

Fortunately, in the case of the steam-hammer he designed in the latter part of his Midvale career, we have an excellent concrete illustration of how a thing which is strictly evolutionary in principle may have what practically amounts to a revolutionary result.

By all who are familiar with his work at Midvale, this steam-hammer is regarded as his crowning achievement there in the strictly mechanical field. H. D. Booth, who at the time was in charge of Midvale's hammer department, tells us that, when in the 1890's he visited the great French gun works of Creuzot and the Krupp works in Germany, he found that the best of the steam-hammers in those leading European establishments could not compare in rapidity and general efficiency to Taylor's. For twelve years, or until it was dismantled to give way to the hydraulic press, the Taylor hammer continued to work without a breakdown, an extraordinary record in view of the fact that all previous steam-hammers had been in the habit of early battering themselves to pieces.

When completed, it appeared to be a startling novelty. "I do not know," says Gantt, "of any more daring piece of engineering construction." Its novelty first of all lay in the



TAYLOR'S FAMOUS STEAM HAMMER
An original drawing found in the Taylor files

fact that it represented a repudiation of the theory that large bodies must move slowly, which theory apparently had universally prevailed among designers of steam-hammers. "Mr. Taylor," says Gantt, "recognized that large bodies could be made to move as rapidly as small ones, if only sufficient power were applied to them. Accordingly he supplemented a falling weight of twenty-five tons by fifty tons of top steam, and designed a hammer whose rate of action was nearly three times as fast as other hammers of the same class." But wherein this hammer was most startlingly novel was that it was designed to keep its alignment, not through great mass and stiffness as had been the case with every other steam-hammer without exception, but through the elasticity of its parts; Taylor insuring this elasticity by designing and supplying with great initial tension an arrangement resembling great spider legs, which consisted of oil-tempered steel bolts four inches in diameter and twenty feet long. And it was dependence upon this principle of elasticity which enabled him to build a hammer which, for its weight, had far greater power than any other hammer ever built, and did not batter itself.

Disguising the incident so as to avoid the appearance of boasting, Taylor thus described how he had gone about designing his hammer:

There was a machine, a large number of which were in common use, and of which there were many designs and types used all over the world. This machine was of such a nature that it battered itself to pieces. Almost all of its parts broke. There was a young engineer who had many of these machines to use in his manufacturing department, and who decided to try to build a machine that would not batter itself to pieces. He spent one or two years in collecting, from all over the world, data about the various machines that had been designed, until he found instances in which some one of the parts of each of the various machines of different designs had never broken. He then copied the design of each of the parts which had not broken, collecting one element from one machine, another from another, another from a third, etc. There was, however, one portion of the machine of which he could find no single instance of a design which had not, at some time or other, broken. He devoted his special energy and ingenuity to the study of this element, and finally evolved what he believed would be a principle which would prevent it from breaking. He then constructed a machine containing all of the parts already existing which had not broken, plus the one of his own design and patent, which he believed would not break, and as a result obtained a machine which lasted for many years without a single breakdown — the first instance of its kind in the history of that art.[1]

So revolutionary was this hammer in the main that, especially when we consider that it cost upwards of $200,000, it seems doubtful that it ever would have got beyond the blueprint stage if its designer had not been in a position and had the courage to go ahead and build it on his own responsibility. Yet it was the outcome of a strictly evolutionary process.

Incidentally it may be mentioned that when the hammer was put into every-day operation, and this was soon after Taylor left Midvale, it was found to contain, as one man expressed it, "several thousand dollars worth of frills," and these had to be stripped from it to enable it to do its best work. Here appears Taylor's tendency to overdo, to make assurance *triply* sure. And it illustrates one of the perverse traits of human nature that apparently there were men who thought the important thing was, not that Taylor designed the most rapid and efficient steam-hammer in the world, and thereby for many years markedly increased the plant's earning capacity, but that he spent a few thousand dollars more than was strictly necessary. However, we shall see that Charles J. Harrah, the younger, then the company's presi-

[1] "Success" lecture.

dent, thoroughly appreciated this mechanical triumph of his young chief engineer. Lift his eyebrows Harrah might over that young man's tendency to make the money fly; at the same time, the indications are that he would have been quite willing to have all his men spend all that Fred Taylor spent, and then some more, provided their spending *saved* the money that Taylor's did.

Returning to those days when he was trying out his wings as a designer, we may report that another thing he had to learn through sad experience was that a machine may be at one and the same time a fine success mechanically and a dismal failure commercially; that while it may admirably do all it is designed to do, it may, for example, be so radical in nature as to require too much educational work to get people to use it. He learned this lesson so well that sometimes he rather went to the opposite extreme. The first electric traveling crane, we are informed, was made at the Sellers plant and installed at Midvale, and for a time Taylor opposed it on the ground that no one would know how to use it.

This may illustrate that though the radical and conservative were finely balanced in him, he was quite human in the sense that his conservatism always was more likely to be manifested in connection with other men's new ideas than with his own. Nevertheless, he did very early form the habit of testing his ideas strictly in the light of what would be serviceable to his employer and to people in general. Hence his concentration on the things around him that were in crying need of improvement, even if their improvement did not require any brilliance or promise any glory. As Barth has told us, it became his genius to recognize the importance of trifles.

But just because trifles are important, the attention he gave to them often worked out to produce brilliant results. He was the first to see that those large lathes which have two or more tool-carriages should be so arranged that their carriages may be operated independently of one another. And we are informed that from this suggestion of his were developed the great gun-lathes that the Sellers plant built for the Washington Navy Yard. In general his attention to trifles showed that even in those early days and at such a progressive establishment as Sellers' the art of design was prone to fall into ruts.

A thing that all the old Midvale hands continue to remember is Taylor's famous chimney, which, starting to climb obliquely to the sky, appeared to change its mind when half way up and so leaned over in the opposite direction. How this came about, Taylor described in his disguised fashion as follows:

> In another establishment [it of course was Midvale] it became necessary to add a number of additional furnaces to the melting department. The flues leading to the chimney of this department were so located that it was very difficult to build a new chimney which should have sufficient capacity to run the old plus the new furnaces without tearing down the old chimney and locating the new one in its place. This would necessarily involve a loss of at least one or two months in time. It appeared to be impossible to add to the height of the present chimney, because, years before, its foundation had sunk unevenly, and the chimney was leaning over so far to one side that its centre of gravity was barely within its base.
>
> There was one young engineer, however, who, realizing the seriousness of a stoppage of two months, proposed to build another chimney on top of the first one, leaned back in the other direction, thus bringing the centre of gravity of the new chimney raised to twice its height back over the centre of the foundation. He carried out this work without even stopping the furnaces for a day. He raised a false sheet iron chimney above where the workmen were building all the time, so that they could build the new chimney with the smoke continually coming out of the top of the old one.[1]

[1] *Ibid.*

Other ways in which Taylor manifested his inventive faculty at Midvale may be seen in the patents he took out in this period; these being for such things as automatic grinders, false tables, chucks, forging and tool-feeding mechanisms, and boring and turning mills. We understand that all of his special tools for the turning and machining of large forgings were as successful as they were ingenious.

It seems quite likely [says Gantt] that if Taylor had adhered to what was then known as strictly engineering, he would have made even a greater reputation than he achieved in the field of management. The work by which he is best known, however, is not what was then in those old Midvale days regarded as strictly engineering. Strange as it may seem, although much knowledge and thought had been devoted to the design of machinery and apparatus, but little study had been given to the possibilities of the men who were to operate that machinery. Even to this day many engineers consider their work done when they have designed and built and demonstrated the possibilities of a piece of apparatus. They seem to feel that the efficient operation of it is not in their province. Mr. Taylor felt otherwise. To him, perfection in design was worthless without efficiency in operation, and at an early date he turned his attention to the efficient utilization of human effort.[1]

[1] Address delivered by Gantt in 1915, and published in *Frederick Winslow Taylor, A Memorial Volume*, p. 63.

BOOK III

DEVELOPING HIS SYSTEM AT MIDVALE

It has been remarked, as an imperfection in the art of ship-building, that it can never be known, till she is tried, whether a new ship will or will not be a good sailer; for that the model of a good-sailing ship has been exactly followed in a new one, which has proved, on the contrary, remarkably dull. I apprehend that this may partly be occasioned by the different opinions of seamen respecting the modes of lading, rigging, and sailing of a ship; each has his system; and the same vessel, laden by the judgment and orders of one captain, shall sail better or worse than when by the orders of another. Besides, it scarce ever happens that a ship is formed, fitted for the sea, and sailed by the same person. One man builds the hull, another rigs her, a third lades and sails her. No one of these has the advantage of knowing all the ideas and experience of the others, and, therefore, cannot draw just conclusions from a combination of the whole.

Even in the simple operation of sailing when at sea, I have often observed different judgments in the officers who commanded the successive watches, the wind being the same. One would have the sails trimmed sharper or flatter than another, so that they seemed to have no certain rule to govern by. Yet I think a set of experiments might be instituted, first, to determine the most proper form of the hull for swift sailing; next, the best dimensions and properest place for the masts: then the form and quantity of sails, and their position, as the wind may be; and, lastly, the disposition of the lading. This is an age of experiments, and I think a set accurately made and combined would be of great use. I am persuaded, therefore, that ere long some ingenious philosopher will undertake it, to whom I wish success.

Benjamin Franklin's *Autobiography*

CHAPTER I

THE "SYSTEMATIC SOLDIERING" HE HAD TO OVERCOME

IT was by insensible degrees that his radical work in applying the scientific method to management grew out of his every-day, homely duties at Midvale.

In a very real sense it can be said that it all began as he came clearly to define his task or problem as foreman. His view of it was that he was there to get output. Not, however, that he ever was bent on getting output regardless of other considerations such as the quality of the work and any strain that might be put on men or machinery. That would have been the crudeness of a speed maniac, and Taylor was a man of intellect. His purpose to get output had its roots in his desire to make the most economical use of his shop's facilities. From the start he was a true engineer in that he was a true economist,[1] with all the economist's hatred of waste and his instinct for conservation.

He himself came to define the problem of the machine shop as that of "removing metal from forgings and castings in the quickest time."[2] It sounds like the simplest of propositions that herein is involved the whole economy of such a shop. Yet the evidence is that if, previous to Taylor, machine-shop officials had any clear conception of the relation between speed and economy, it influenced their actions only sporadically and fitfully.

[1] This term, of course, is used here in the sense of one who effects scientific economies, rather than in the sense of one versed in economics or the science of political economy, though, for that matter, Taylor had a firm grip on at least some of the elementary principles of economics, as must be the case with every engineer worthy of the name.

[2] *On the Art of Cutting Metals*, par. 136.

As a matter of fact, there are few rarer spectacles than that of a person beginning *at the beginning* by sitting down to figure out deliberately and to define clearly the nature of his purpose, problem, task or job. But this is in very truth the scientific way; and it may well be held to mark Taylor's beginning with the scientific method. Thus he determined *what* he had to do, and could then proceed to analyze the "what" into the how; that is, break up his master task into the detail tasks necessary for its accomplishment; and it is to be observed that no task or problem really can be grasped until it is known and studied in detail.

He found that his master task or problem of getting metal out in the quickest time naturally divided itself into two principal sets of detail problems; the one having to do with the mechanics of the shop's equipment, and the other with the workers' operation of that equipment.

Now, whenever a start is made with Scientific Management, it is in the natural or logical order that mechanical conditions be looked into first, since it is obvious that what labor can do all depends on the nature and condition of its implements. Particular circumstances, however, often prevent things from being taken up in their logical order, and this was the case when Taylor became a foreman. Of what use for him to study the mechanical equipment as long as the men were resolved that the output should be so much and no more? Thus, right at the outset of his career as an industrial economist he was confronted by the deeply significant fact (which his fellow engineers as a class and industrial folk in general were very slow in getting a grip on) that as there is no machinery so automatic that it does not have to be cared for and have its work supplied to it by human beings, *all other industrial problems are swallowed up in the problem of human relations.*

That we may understand his course in setting out to solve this problem, we must have some detailed knowledge of what had been and were then the common methods of dealing with labor and of how these entered into the situation at Midvale — we must see, in fact, just what lay behind the stubborn resistance of Taylor's men to the pressure he brought to bear on them to get them to stop limiting their output.

All along management had been striving to get workmen to do what is called a good, fair, or full day's work, a thing that no one is likely to dispute it is right for them to do — not, at all events, when it is stated as an abstract proposition. Certainly Taylor never had any doubts in this connection whatever. It was not merely that he saw that it is only as workmen give of their best that economic use can be made of the costly machinery of modern industry. The spectacle of a man doing less than his best was to him *morally* shocking. He was concerned for the effect of it on the man's own character. He enthusiastically believed that to do anything less than your best is to add to the sum of the world's unrighteousness.

Yet there is the fact that even while he resorted to everything he could think of to get his men to increase their production, he was compelled to sympathize with their resistance. As the fight progressed, so he testified, one of his intimate friends among the workmen occasionally would inquire of him in a "sober, serious" way: "Fred, if you were in my place, would you do what you are asking me to do?" And sportsman that he was, he always would reply: "No; if I were in your place, I would fight against this as hard as any of you. Only if I were you," he would add shrewdly, "I would not make a fool of myself. When the time comes that you see I am succeeding, I would work up to a proper speed."

To resolve this rather mixed situation, we first must distinguish between what Taylor called natural soldiering and what he called systematic, and then see to what systematic soldiering is due.

As he defined it, natural soldiering proceeds from "the natural instinct and tendency of men to take it easy," while the systematic form proceeds from the workmen's "more intricate second thought and reasoning caused by their relations with other men."[1]

Of course there are many workmen who are so ambitious that they will of their own volition do more than is required of them, and so take what Taylor called the "real, quick road to success." However, it certainly is true of the great bulk of us that we are just about as lazy as we dare to be; and though there is a school of thought which apparently would have it that every workman is a paragon of industry and all the other virtues, we may readily believe that, after all, Taylor was right and working people are just folks.

In so far as soldiering is due simply to a human tendency to take things easy, it can readily be broken up by a forceful manager. However lazy a man may be, he usually will concede, deep down in his heart, that his laziness ought to be overcome, if not by himself, then by someone else. Certainly, if all Taylor had had to contend with was "natural" soldiering, he, with his remarkable ability to ginger up the slothful, could have wiped it out in short order. But the truth is that, long before he entered industry, that other form of soldiering he called systematic had begun to be widely practiced.

It would seem that the rudiments of systematic soldiering first appeared in the shop and works in consequence of an evil that was inherent in the primitive way of dealing with workmen which Taylor described as that of "bringing a number of men together on similar work and at a uniform rate of pay by the day."

> Under this plan the better men gradually but surely slow down their gait to that of the poorest and least efficient. When a naturally energetic man works for a few days beside a lazy one, the logic

[1] *Shop Management*, p. 30.

of the situation is unanswerable: "Why should I work hard when that lazy fellow gets the same pay that I do and does only half as much work?"[1]

It will be understood that in the philosophy of men like Taylor it all along, from the *ultimate* point of view, had been in the interest of workmen collectively and individually to do their best. As workmen give of their energy, so ultimately there is brought into the world those goods which workmen consume; the greater the quantity, the lower the price; and the lower the price, the greater every workman's *real* wages. This became with Taylor more and more of a vital truth. We have seen, again, that his observation was that as a man goes ahead and does his individual best he ultimately must receive his individual reward in the reaction that his course has on his character and in his ability to fire his boss at will and so command in wages the utmost value of his skill. But most men are not far-sighted enough to see this, and management, of course, must take human nature as it is. It, in fact, was essentially the weakness of the day-work plan that it required too much of human nature. As most men become discouraged if they do not get their reward immediately, it was the tendency under the day-work plan for the output of the slothful to become the standard for all.

But this, as has been suggested, is systematic soldiering only in a rudimentary form. What gave systematic soldiering its first real start is the belief, which at least in Taylor's time was almost universal among workmen, that there is only so much work to do in the world, and that therefore if a man does more work than he is compelled to do, he will be depriving a fellow of work.

While very serious indeed, systematic soldiering that is actuated by this belief is not as serious as might be, since it usually involves nothing more than careful refraining from

[1] *Ibid.*, p. 31.

doing one's best. Moreover, as the majority of us are influenced less by altruistic considerations than by those of self-interest, soldiering that is motivated solely by a desire to "make" or leave open work for others can be maintained only where there is a manager not sufficiently interested in breaking it up to take more or less strong measures, or where joint action by the men is enforced by a union. And this brings us to the fact that while trades-unionism began to become influential in this country in the 1860's, it never was able to make much headway in the iron and steel industry during Taylor's lifetime. If in 1892, the year of the famous Homestead strike, the Amalgamated Association of Iron and Steel Workers was able to report a membership of about 24,000, this was mainly confined to the Pittsburgh district, and the Homestead strike resulted so disastrously for the union as to give a body blow to unionism throughout the whole industry.

With his shop an "open" one, we may be entirely sure that Taylor would not have had to fight his men for three years if they had been resolved on soldiering simply to "make" work. What he there was confronted with was a more stubborn and far more subtle form of systematic soldiering, one involving a regular system of deceit, with the object of keeping the boss ignorant of how fast work could be done.

Strange to say, this highly pernicious form owed its start in industry to the introduction of a wage-system representing a progressive step. What we refer to is the piece-rate system, and more particularly to that which, whatever refinements it may have, is based on the old method of estimating, chiefly from past performances, how long it should take a skillful workman to do a piece of work, and then, with the wages in mind that it is customary to pay in the particular locality for the grade of labor involved, so figuring the price per piece that the workman will just about earn this wage, provided he applies himself with industry.

This old piece-rate system is called a step forward because it represented an attempt to get away from treating workmen *en masse* and individualize them. It was designed to be the answer to the question that always kept coming up under the day-work plan as to why the more energetic and the more efficient should do more work than the less energetic or efficient. It also was an attempt largely to abandon the appeal to the motive of fear and substitute for it the appeal to the motive of self-interest; the idea being that if the men were paid so much per piece for the work they turned out, they would not have to be driven to do their best, but each would have an incentive originating in himself. In the old or "straight" piece-rate system at its best we have, in fact, a good example of the "management of initiative and incentive."

However, as a means of inducing men to do their best, straight piece-work generally had proved a failure before Taylor entered industry. The main reason was that employers generally had made it a practice to cut their rates repeatedly, because the rates as set usually enabled the workmen to earn wages greatly in excess of what the rates had been designed to enable them to earn. Under the stimulus of the piece-rate, the workmen showed they could turn out work in much less time than anyone, judging from their past performances, would have supposed. Not always was the rate-cutting due to the unwillingness of employers to see their men earn more than the usual amounts. Though often mean, it probably was in the majority of cases unavoidable.

A rate is set. An energetic worker starts upon the job and in each passing year discovers new tricks of the trade, new methods of enlarging the output. If the piece-rate remained constant, wages would rise to unusual levels. Now the employee undoubtedly deserves a reward for improving the methods of his work, but it is questionable whether he is entitled to as great a return as an unreduced piece-rate would yield him. The improvements are probably simple ones that almost anyone could devise, and which a good man ought to be expected to make, given the opportunity. Just as the manufacturer expects to see the savings due to his own improvements ultimately reflected in reduced prices to the purchasing public, so the piece-worker has no inalienable right to enjoy perpetually a given rate. Especially would the employer in the above illustration be justified in cutting the rate upon giving the job to a new man. For why should a workman earn unheard of wages who has done nothing except adopt methods invented by his predecessor or neighbor? Finally, even the most generous-hearted employer would be unable to pay high rates for work when his less conscientious competitors are figuring their selling prices on a lower basis.[1]

All these things doubtless had entered into rate-cutting before Taylor began his career, and in addition there was the fact that cuts often had been enforced if only because a rate had been set which enabled some men to receive wages out of all proportion to the sums earned in the same plant by men doing work requiring equal skill.

But whether the cutting was avoidable or unavoidable, its effect on workmen was equally unfortunate and mischievous.

Even the most stupid man [wrote Taylor], after receiving two or three piece-work " cuts " as a reward for his having worked harder, resents this treatment and seeks a remedy for it in the future. Thus begins a war, generally an amicable war, but none the less a war, between the workmen and the management. The latter endeavors by every means to induce the workmen to increase the output, and the men gauge the rapidity with which they work, so as never to earn over a certain rate of wages, knowing that if they exceed this amount the piece-work price will surely be cut, sooner or later.

But the war is by no means restricted to piece-work. Every intelligent workman realizes the importance, to his own interest, of starting in on each new job as slowly as possible. There are few foremen or superintendents who have anything but a general idea of how long it should take to do a piece of work that is new to them.

[1] *Scientific Management*, by Horace B. Drury, p. 35.

Therefore, before fixing a piece-work price, they prefer to have the job done for the first time by the day. They watch the progress of the work as closely as their other duties will permit, and make up their minds how quickly it can be done. It becomes the workman's interest then to go just as slowly as possible, and still convince his foreman that he is working well. . . .

Thus arises a system of hypocrisy and deceit on the part of the men which is thoroughly demoralizing, and which has led many workmen to regard their employers as their natural enemies, to be opposed in whatever they want, believing that whatever is for the interest of the management must necessarily be to their detriment.[1]

The sum of it was that the rate-cutting that had been done before Taylor entered industry had taught workmen that employers fix upon a maximum sum which they feel is right for their men to earn, whether they work by the day or the piece, and that when an employer is convinced a man can do more work than he has done, he sooner or later will find some way of compelling the man to do it at the same pay.

In view of all this, then, we can readily understand why, with the straight piece-work system Brinley had established at Midvale, the men in the machine shop were enraged when Taylor started in to force them to increase their production. There is no evidence that any rate-cutting had been done at Midvale, but those mechanics were perfectly well aware of what was the general practice.

After he had, in his testimony before the Special House Committee, told of how widespread had been the custom of cutting piece-rates, Taylor said:

Under those conditions it would take an exceedingly broad-minded man to do anything else than adopt soldiering as his permanent policy. I will not say this soldiering is the best policy for the workman to adopt, even for his own best interest in the long run, but I do say that I do not blame him for doing it.

[1] Paper of 1895, *A Piece-Rate System.*

In his testimony before the Industrial Relations Commission he reinforced this by saying of his own habit of soldiering as apprentice and mechanic: "I was wrong. It would have paid me and the other people [his fellow workmen] to have taken our cut and gone right ahead. It is a good deal to ask of a human, however — to ask anyone to accept that cut and smile over it and think it is a good thing for you."

It has been said that "good enough is the greatest enemy of the best." Probably there was not a man connected with the Midvale management who did not know that the workmen could, with ease, do more than they were doing, but their output was accepted as good enough until Taylor became of the management. Actually it was an ugly situation — it always is when workmen think it is to their interest to give as little as possible and the management is bent on paying no more than it can help — and it bespeaks the high value of sincerity and earnestness that it took these qualities as they were embodied in young Taylor to bring this situation out in bold relief.

He testified that, in consequence of his two or three years of fighting with his men, he succeeded, as near as he could remember it, "in doubling the output of the men on the whole." But he got no satisfaction out of it. It was during these years that he was doing his home study at night, and it would appear that in his later life he attributed the weakening of his nervous system to his working these long hours. However, there can be no doubt that what weakened him was not so much the work by itself as the friction that went with it. On the witness stand he characterized such fighting as he had done with his men as "mean," "contemptible," "despicable," and "horrible." He felt badly about it, that is certain; in fact, he did a deal of worrying over it, and it was this worry, this strain, that made him feel in his twenties "like an old man." Moreover, his thirst for the best was not slaked; though he had doubled the output of his men, he was sure it did not yet represent a *full* day's work.

It is one of the hindrances to harmony in industry that it is inevitable that men who rise to and in the management should be men who scorn the present and play for the future, and that it is more or less inevitable that such men should feel contempt or commiseration bordering on it for those who cannot see beyond the next pay day. To rise superior to this feeling calls for real magnanimity. Though the cast-your-bread-upon-the-water idea was of the warp and woof of his philosophy, and he respected no man who was willing to give only so much for so much, Taylor did have this magnanimity. Not only did he have sufficient bigness of soul to put himself in the place of the humblest, but he cultivated it as a faculty; he gave his disciples a leaf straight out of his own book when in his later years he would enjoin upon them: "Find out what is in the men's minds. Look at things through their eyes."

So it was that he sympathized with his men even while he fought with them, and so it was that when he came to analyze the cause of such fighting, he was able to go straight to the root of the difficulty.

CHAPTER II

FIRST STEPS IN APPLYING SCIENCE TO MANAGEMENT

THIS is the vivacious way he expressed it when testifying before the Industrial Relations Commission:

> When I got to be foreman of the shop and had finally won out and we had an agreement among the men that there would be so much work done — not a full day's work, but a pretty good day's work — we all came to an understanding and had no further fighting. Then I tried to analyze it, and I said: "What has been the matter with all this thing?" I said: "The main trouble with this thing is that you have been quarreling because there have been no proper standards for a day's work. You do not know what a proper day's work is. Those fellows know ten times more than you do, but, personally, we do not know anything about what a day's work is. We make a bluff at it and the other side makes a guess at it and then we fight. The great thing is that we do not know what is a proper day's work."

Thoroughly appreciating that his men's motive for soldiering lay in their fear that an increase in their production would be used as a basis for setting new piece-rates, he saw that if piece-rates were based, not on their actual performances in the shop, but *on the facts as revealed by a careful investigation,* their motive for soldiering would be destroyed.

Then, again, what he was after was a *full* day's work; and how could he either force it or make it to the interest of his men to deliver it until he knew what it was?

There, in truth, was the nub of the difficulty with the piece-rate system as then practiced; not knowing what a worker ought to be able to do with his skill plus his mechanical equipment, management could not with certainty set a rate that, *as the worker did his best*, would not yield him a return out of all proportion to his skill.

Really it came down to the common-sense proposition that the one best way to get what you want — the way that most successfully avoids misunderstanding and quarreling — lies through *knowing* what you want and *specifying* it.

So Taylor set out accurately to determine (*i.e.*, on a basis of fact) what his men ought to be able to do with their equipment and materials. As some of our technical friends now phrase it, he sought to learn the "content of the workers' skill." It was the course that he himself came to describe as that of "gathering in on the part of those on the management's side of all the great mass of traditional knowledge which in the past has been in the heads of the workmen and in the physical skill and knack of the workman," and of "recording it, tabulating it, and, in many cases, finally reducing it to laws, rules, and even to mathematical formulae." [1]

Here, then, aside from his action in clearly defining his master problem as foreman, was his beginning with the scientific method in connection with management — the beginning which, because it was the logical one and his qualities were what they were, made it inevitable that he should extend the scientific method to all of the elements of management and so bring into existence all of the phenomena of Scientific Management or of that coherent and logical whole destined to become known as the Taylor System.

He embarked on this course, not because he had any theory he was desirous of trying out, but simply because he was resolved to discharge *thoroughly* that practical duty of getting output which supposedly rests upon every foreman. There was no essential difference between his practical problem and

[1] Testimony before Special House Committee.

that of foremen and superintendents in general. The only difference was that *he* could not be content with any half-way, temporary, or compromise solution, but must needs seek a complete, permanent, and positive solution, and that he had the *prescience* to realize that such could be reached only on a basis of fact.

Informing all his course was his social instinct. It was this instinct that was wounded by his quarrels with his men and made him wish to be counted out of any game in which such quarreling was necessary. When testifying in 1912, he said with reference to his first steps in developing his system: " My whole object was to remove the cause of antagonism between the boss and the men who worked under him; to try to make both sides friends in the place of tactical enemies." A man is not always the best judge of his own motives; he is likely to think they are far simpler than they really are; and in explaining his course Taylor probably failed to take sufficiently into account the promptings in him of the engineer pure and simple, of the hater of waste in the abstract. Even so, there can be no doubt that it was nothing more or less than his social instinct which lent passion to his instinct for economy. It was through his social nature, again, that he was inclined to see in his own problems and those of his employers the factors that were common to industry in general. At the best his men's agreement to do a "pretty good day's work" represented merely a promise given to him personally by a limited number of individuals. There was nothing in the situation pointing to an enduring peace. Until workmen gave of their best as a matter of every-day practice, attempts to force them to do so always would be likely to be made. They themselves could not determine what they ought to do; upon management must rest this burden.

So far from beginning with any system, he had no idea that he was on his way to developing one. Having in mind only the project of learning at least as much as his men collectively knew about their trade, he thought he could get to the bottom of the whole business in about six months! And as he went on and on, so to speak, taking the further steps made necessary by those he had already taken, he for many a year remained innocent of any purpose to develop a comprehensive system of a particular type.

Nevertheless, it now is to be recognized that from the moment he embarked on his course in seeking the knowledge he did, he unconsciously was moving toward the introduction into management of a philosophy calling for a revolutionary change in the mental attitude then prevailing among managers, and which continued, if in lessening degree, to prevail among them throughout his lifetime. While all along it had been held with practical unanimity that the details of labor operations were things to be left almost entirely to the judgment of those who actually did the work or who practiced the trade with which the operations were connected, Taylor's action in seeking to find out what his men ought to be able to do with their equipment and materials included, as a necessary consequence, the *prescribing* of what they should do, or the assignment to them of tasks carefully measured in accordance with the knowledge he developed.

Of course, if nothing like this thinking of Taylor's ever had been known before on land or sea, it would have been eccentric and therefore worthless thinking. And this brings us to the fact that as an industrial economist, Taylor probably had his most striking precursor in Charles Babbage, the British mathematician and mechanician whose work, *The Economy of Machinery and Manufacture*, published in 1832, we already have referred to as having had an early influence in England in placing the designing of machinery on a scientific basis.

In addition to the attention he gave machinery in this work of his, Babbage attempted to deduce from manufacturing as then practiced the general principles controlling it. He at least suggested the extension of specialization beyond manual labor to mental — that is, to the work of management — and he went on to remark that "in order to succeed in a manufacture, it is necessary not merely to possess good machinery, but that the domestic economy of the factory should be most carefully regulated."

More interesting still, Babbage showed that, in 1760, a Frenchman had listed the labor operations entering into the manufacture of pins, and had recorded with the aid of a watch the time which the workmen had taken to perform each of these operations while turning out 12,000 pins; the object being to determine the cost of the pins in detail. Babbage not only printed the Frenchman's table, but got up a similar one for English manufacture in his own day.

Evidently, from considering how machinery should be designed, Babbage was led on to consider how it should be handled. But it does not appear that Babbage's book, as in this way it foreshadowed the development of a science of management corresponding to a science of mechanical devices, had the slightest influence upon industry in his own or in any other country. In this particular, he was altogether too far in advance of contemporary manufacturing intelligence.

And here we are confronted by a curious situation: We have seen that when Taylor began his industrial career in the 1870's, machine design in America was generally on an empirical basis, whereas in England it had made great strides along scientific lines. Neglecting, however, to act systematically on Babbage's principle that it is not enough to possess good machinery, but that the economy of the factory or shop should be "most carefully regulated," the English practically left off, as far as the scientific method was concerned, with the development of these machines by which metal-cutting tools are made to do their work. On the other hand, Taylor, starting in the 1880's, did systematically act on that Babbage principle; and so it was this American who initiated and led the work of scientifically studying the speeds at which the machines should be run in the shop, thereby bringing about, as one feature of his work — and it was a feature that deeply wounded the pride of the English — the development of excellence, as by shaping and heat treatment, in metal-cutting tools themselves.

While it was left to Taylor to give substance to Babbage's ultra-advanced idea of a science of management, it is not to be supposed that he ever heard of Babbage when, intent on the highest economy of the machine shop, he set out in the 1880's to determine what his men ought to be able to do with their equipment and materials. Probably the only man from whom he received direct inspiration was William Sellers.

Mention has been made of the fact that Sellers as early as 1876 attempted to have the cutting tools used in his plant issued to the workmen ready ground to shapes and angles adopted as standard after some investigating. This may be taken as illustrating that all along Taylor had contemporaries who approached and grappled with problems of management in a truly scientific spirit. However, it also illustrates that the work of these other men was unsystematic and confined to a single element or only a few of the elements of management; so that, as Taylor came to express it, there was "great unevenness or lack of uniformity shown, even in our best run works, in the development of the several elements which together constitute what is called the management." [1]

So successful were some of Taylor's contemporaries in applying the scientific method to various details of management that, as he went on, Taylor frequently was led to pay their work the sincere tribute of borrowing from it. Wherein his course was unique was that from the beginning it lay in the

[1] *Shop Management*, p. 17.

direction of introducing the scientific method into management *as a matter of all-around, consistent, every-day cultivation and practice.* And this was because he was the only one who started at the beginning both in his thinking and in his action; which is to say that he was the only one who, seeing that it is the task of management to bring about the most economical use of labor and equipment entering into production, and seeing also that to fulfill this task the management must determine what the output of the labor aided by the equipment should be, *resolutely set out to do this and stuck to it.*

The record indeed shows that many thinkers besides Taylor saw clearly how advantageous it would be for management to determine possible output. It was widely recognized that management's lack of knowledge in this connection was at the bottom of the chronic troubles with piece-work plans. But what the record also shows is that the best minds up to this time had all come to the conclusion that for the management to determine possible output was impossible. We shall see, in fact, that several years after Taylor had set out to do this very thing, but before he was ready to tell anything of his work, the leading papers dealing with management read before the American Society of Mechanical Engineers all were based on this supposed impossibility, and offered compromise wage-payment plans designed to minimize the evils that were inevitable in the absence of such knowledge.

To tell Taylor that anything was impossible was just about the one best way to stimulate him to go after it. And this was the case when, asking William Sellers for permission to spend some money for experiments designed to reveal what his men ought to be able to do with their machines, he was told that the thing had been tried before and could not be done. If Sellers at length consented, it was mainly because he felt that Taylor was entitled to some reward for having already got his men to increase their production.

CHAPTER III

ORIGIN AND NATURE OF TIME STUDY

THESE experiments, Taylor told the Special House Committee, were started along a variety of lines. One line was that which has come to be generally known as "motion study" or "time study." Telling how a young man was equipped for this study with a stop watch and ruled and printed blanks, Taylor continued:

This man for two years and a half, I think, spent his entire time in analyzing the motions of the workmen in the machine shop in relation to all the machine work going on in the shop — all the operations, for example, which were performed while putting work into and taking work out from the machines were analyzed and timed. I refer to the details of all such motions as are repeated over and over again in machine shops. I dare say you gentlemen realize that while the actual work done in the machine shops of this country is infinite in its variety, and that while there are millions and millions of different operations that take place, yet these millions of complicated or composite operations can be analyzed intelligently and readily resolved into a comparatively small number of simple elementary operations, each of which is repeated over and over again in every machine shop. As a sample of these elementary operations which occur in all machine shops, I would cite picking up a bolt and clamp and putting the bolt head into the slot of a machine, then placing a distance piece under the back end of the clamp and tightening down the bolt. Now, this is one of the series of simple operations that take place in every machine shop hundreds of times a day. It is clear that a series of motions such as this can be analyzed, and the best method of making each of these motions can be found out, and then a time study can be made to determine the exact time which a man should take for each job when he does his work right, without any hurry and yet who does not waste time. This was the general line of one of the investigations which we started at that time.

At the same time, another series of investigations was started which I shall describe later, and which resulted in developing the art or science of cutting metals.

Before starting to describe these experiments, however, I want to make it clear to you that these scientific experiments, namely, accurate motion and time study of men and a study of the art of cutting metals,[1] which were undertaken to give the foreman of the machine shop of the Midvale Steel Works knowledge which was greatly needed by him, in order to prevent soldiering and the strife which goes with it, marked the first steps which were taken in the evolution of what is called scientific management. These steps were taken in an earnest endeavor to correct what I look upon as one of the crying evils of the older systems of management. And I think that I may say that every subsequent step which was taken and which has resulted in the development of scientific management was in the same way taken, not as the result of some preconceived theory by any one man or any number of men, but in an equally earnest endeavor to correct some of the perfectly evident and serious errors of the older type of management.

The question as to the extent to which time and motion study was original with Taylor often was raised in his lifetime. His own attitude in this connection was made plain when, in 1912, the Sub-Committee on Administration of the A.S.M.E.[2] dealt with time study in its majority report on "The Present State of the Art of Industrial Management."

To begin with, this committee formulated a basic principle, that of "transference of skill," for all modern industry. By

[1] It will be seen that these two types of experiments correspond to the two principal sets of detail problems into which his master problem of getting metal cut in the quickest time had divided itself; the one set having to do with the mechanical equipment, and the other with the workers' use of that equipment.

[2] Hereinafter the American Society of Mechanical Engineers will be so designated.

the phrase quoted it apparently meant, first, such a process as takes place when skill to do work is put into a piece of mechanism, and, second, such a process as takes place when best methods of operating machines, handling materials, and so on, are determined in advance by the management and the workman acts in accordance with this predetermination. While making no specific mention of Taylor's work, the committee referred to what Adam Smith in his *Wealth of Nations* (1776) had written about the listing of operations entering into the manufacture of pins, quoted from Charles Babbage's *Economy of Machinery and Manufacture,* and reprinted in the appendix to its report the tables Babbage had presented as those used in France in the eighteenth century and later on in England in connection with the recording and timing of pin-manufacture operations.

From the paper Taylor contributed to the discussion of this A.S.M.E. report we shall quote at length, not only because of its interest in connection with the question of the origin of time study, but also because Taylor here made his most careful attempt to define the nature of this thing which had been so generally misunderstood.

The historical portion of the report [wrote Taylor] shows careful study, and is evidently the result of much research. In certain particulars, however, it is somewhat misleading; that portion of it, at least, which includes the quotations from Adam Smith, etc., and particularly tables 1 and 2, given in the Appendix.

Although the fact is not specifically stated, still the general impression from reading this part of the report is that "time study," which is the foundation for "the transference of skill from the management to the men," was practically carried on in 1760 and in 1830, as it is now under scientific management. This is, however, far from the truth, and in the interest of historical accuracy it may be desirable to make a statement as to the beginning of "time study," although I realize that questions as to who started time study, and when it was started, are of very little consequence, the important questions being, what is time study? and, how shall we make it more useful?

Time study was begun in the machine shop of the Midvale Steel Company in 1881, and was used during the next two years sufficiently to prove its success. In 1883, Mr. Emlen Hare Miller was employed to devote his whole time to "time study," and he worked steadily at this job for two years, using blanks similar to that shown in Par. 367 of "Shop Management." He was the first man to make "time study" his profession.

It is true that the form of Tables 1 and 2, given in the Appendix to the Committee's report, is similar to that of the blanks recording time study, but here the resemblance ceases. Each line in Table 2, for instance, gives statistics regarding the average of the entire work of an operative who works day in and day out, in running a machine engaged in the manufacture of pins. This table involves no study whatever of the movements of a man, nor of the time in which his movements *should* have been made. Mere statistics as to the time which a man takes to do a given piece of work do not constitute "time study." "Time study," as its name implies, involves a careful study of the time in which work *ought* to be done. In but very few cases is it the time in which the work actually was done.

Previous to the development of "time study" in the Midvale Steel Works, there had in all probability been many instances in which men have carefully studied and analyzed the movements of other men, and have timed them with watches. (No such instances have, however, come to my personal attention.) Any such former work was without doubt confined to isolated cases, and was of short duration; and (most important from the historical point of view) it did not lead to the development of a new trade, or, more properly, to a new scientific occupation, "the profession of time study."

Any former efforts of this kind would bear the same general relation to the time study done in the Midvale Steel Works that the many early attempts at flying bear to the work of the Wright brothers. The Wright brothers started "man flying." The Midvale Steel Works started the "profession of time study." (I do not of course intimate that the two developments are of equal importance.)

Time study is the one element in scientific management beyond all others making possible the "transfer of skill from management to men." The nature of time study, however, is but imperfectly understood, and it is therefore important to define it clearly. "Time study" consists of two broad divisions, first, analytical work, and second, constructive work.

The analytical work of time study is as follows:

a Divide the work of a man performing any job into simple elementary movements.

b Pick out all useless movements and discard them.

c Study, one after another, just how each of several skilled workmen makes each elementary movement, and with the aid of a stop watch select the quickest and best method of making each elementary movement known in the trade.

d Describe, record and index each elementary movement, with its proper time, so that it can be quickly found.

e Study and record the percentage which must be added to the actual working time of a good workman to cover unavoidable delays, interruptions, and minor accidents, etc.

f Study and record the percentage which must be added to cover the newness of a good workmen to a job, the first few times that he does it. (This percentage is quite large on jobs made up of a large number of different elements composing a long sequence infrequently repeated. This factor grows smaller, however, as the work consists of a smaller number of different elements in a sequence that is more frequently repeated.)

g Study and record the percentage of time that must be allowed for rest, and the intervals at which the rest must be taken, in order to offset physical fatigue.

The constructive work of time study is as follows:

h Add together into various groups such combinations of elementary movements as are frequently used in the same sequence in the trade, and record and index these groups so that they can be readily found.

i From these several records, it is comparatively easy to select the proper series of motions which should be used by a workman in making any particular article, and by summing the times of these movements, and adding proper percentage allowances, to find the proper time for doing almost any class of work.

j The analysis of a piece of work into its elements almost always reveals the fact that many of the conditions surrounding and accompanying the work are defective; for instance, that improper tools are used, that the machines used in connection with it need perfecting, that the sanitary conditions are bad, etc. And knowledge so obtained leads frequently to constructive work of a high order, to the standardization of tools and conditions, to the invention of superior methods and machines.

It is unusual to make a study such as this of the elementary movements of the workmen in a trade. The instances in which this has been done are still rare. Most of the men who have made what they call "time study" have been contented with getting the gross time of a whole cycle of operations necessary to do a particular piece of work, and at best they have thrown out the time when the workman was idle, or evidently purposely going slow.

Taylor's correspondence reveals that when he stated in the foregoing paper that time study was begun at Midvale in 1881, and that Emlen Hare Miller was employed in 1883 to devote his whole time to it, these dates were fixed from his memory, which we know was usually poor. However, as he went to Midvale in 1878, became a boss in the machine shop late in that year or early in 1879, and quarreled with his men "two or three years" before he resolved to acquire exact knowledge of what was a full day's work for them, the probabilities are that his dates are approximately correct; and to this confirmation is lent by the fact that he stated that his time-study and metal-cutting investigations were started at or about the same time, and in his paper *On the Art of Cutting Metals* we find it printed (page 37) that the first of his metal-cutting discoveries were made in 1881.

At the same time, it is to be considered that, on the basis that "mere statistics as to the time which a man takes to do a given piece of work do not constitute time study," it hardly would be possible for anyone to fix an exact date for the beginning of *true* time study. This because the thing did not spring full panoplied from Taylor's brain, but, as was typical of his revolutionary work in general, was a gradual development from a humble beginning, the manner of it being as follows:

The work of his shop principally was that of machining locomotive tires and car axles, and was repetitive. There was, however, some miscellaneous work; and when the drawing was ready for a new job and an attempt was made to figure its cost, the question arose as to what material would be needed and how long the work would take. Always a fairly accurate estimate could be made as to the material, but when the foreman was called in to settle the time question, all he had to guide him at the best were such records as he might have of the total time it had taken to do former jobs of a more or less similar nature; and it is plain that estimates based on such statistics represented guess work almost pure and simple. Incidentally it was by such guessing also that the foreman right along had set for the workmen a piece-rate in connection with the new job.

Now, few things could have been more abhorrent to Taylor than this guessing; moreover, it eventually "occurred" to him that "it was *simpler* to time with a stop-watch each of the elements of the various kinds of work done in the place, and then find the quickest time in which each job could be done by summing up the total times of its component parts, than it was to search through the time records of former jobs and guess at the proper time and price." [1]

From this it is clear that at the start he had for his object only the improvement of the statistics which long had been

[1] *Shop Management*, p. 148.

used in his shop, and there can be no doubt that for a period he attempted only to record such times as actually were taken. Even here, however, his timing was greatly different from that mentioned by Babbage as having been done in France in 1760. The French observer, one Perronet, simply listed the various processes entering into pin manufacturing (such as straightening and cutting the wire, pointing the pins, and heading the pins), and his timing was confined to recording the gross time it took the workmen to complete each of these divisions of the work, on the basis of lots of 12,000 pins. And when Babbage, seventy years later, got up a new table for English manufactures, he also contented himself with recording these gross times. On the other hand, it will be seen that from the very beginning Taylor was concerned with timing the *elementary motions* of which individual labor operations consist; which is to say that his work from the beginning lay along the lines of what these days is called job analysis, or the splitting up of jobs into their component parts.

Back of it all was his observation that, no matter how much the jobs coming into his shop might vary, they represented but different combinations of the same elemental motions. If this fact ever had been observed before, it does not appear that it was *deliberated upon* and its significance thus grasped, and in such case the observation was not a real one. What can be affirmed with positiveness is that Taylor was the first to *act* on this fact; that is, really act on it in the sense of pushing the thing through to its logical conclusion.

It will be recalled that when he was at Phillips Exeter, he was profoundly impressed by his observation of the way his professor of mathematics, "Bull" Wentworth, had timed the work of the students in solving various problems, and so was able to give out standard lessons in the sense that he knew how much time the average boy would take to do them. All the indications are that to the extent Taylor was indebted to

15,981. 7-16-87—1500.

The Midvale Steel Co.

Form D—124. Machine Shop, ...18 ......

Estimates for Work on Lathes.

OPERATIONS CONNECTED WITH PREPARING TO MACHINE WORK ON LATHES AND WITH REMOVING WORK TO FLOOR AFTER IT HAS BEEN MACHINED

OPERATIONS.	TIME IN MINUTES.
Putting chain on, Work on Floor,	
" " Work on Centres,	
Taking off chain, Work on Floor,	
" " Work on Centres,	
Putting on Carrier,	
Taking off "	
Lifting Work to Shears,	
Getting Work on Centres,	
Lifting Work from Centres to Floor,	
Turning Work, end for end,	
Adjusting Soda Water,	
Stamping,	
Centre-punching,	
Trying Trueness with Chalk,	
" with Callipers	
" with Gauge,	
Putting in Mandrel,	
Taking out "	
Putting in Plug Centres,	
Taking out "	
Putting in False Centres,	
Taking out "	
Putting on Spiders,	
Taking off "	
Putting on Follow Rest,	
Taking off "	
Putting on Face Plate,	
Taking off "	
Putting on Chuck,	
Taking off "	
Laying out,	
Changing Tools,	
Putting in Packing,	
Cut to Cut,	
Learning what is to be done,	
Considering how to Clamp,	
Oiling up,	
Cleaning Machine,	
Changing Time Notes,	
Changing Tools at Tool Room,	
Shifting Work,	
Putting on Former,	
Taking off "	
Adjusting Feed,	
" Speed,	
" Poppet Head,	
" Screw Cutting Gear,	

Name,

Sketch,	Number,
Order,	Weight,
Metal,	Heat No.
Tensile Strength,	Chem. Comp.,
Per Cent. of Stretch,	

HARDNESS, Class

OPERATIONS CONNECTED WITH MACHINING WORK ON LATHES.

OPERATIONS.	Speed.	Feed.	Cut.	Tool.	Inches.	Minutes.
Turning Feed In,						
" "						
" Hand Feed,						
" "						
Boring Feed In,						
" "						
" Hand Feed,						
" "						
Starting Cut,						
" "						
Finishing Cut,						
" "						
Fillet,						
"						
"						
Collar,						
"						
Facing,						
"						
Slicing,						
"						
"						
Nicking,						
"						
Centreing,						
"						
Filing,						
"						
Using Emery Cloth,						
" "						
TOTAL						

Machining—Two Heads Used,
" —One Head Used,
Hand Work,
Additional Allowance,

TOTAL TIME,
HIGH RATE,
LOW RATE,

Remarks:

SIGNED, TOTAL, Time actually taken,

AN EARLY TAYLOR FORM

Showing the division of an operation into unit elements, and the estimating of the total operation time from unit element times; also the recording of the proper feed, speed, cut and tool. Midvale, 1887

anyone else for the general idea of timing work, his indebtedness was not to anyone in industry, but, curiously enough, to his old professor of mathematics solely.

At first he did his listing and timing of motions in person, and in connection with the regular work of the shop while the workmen did not know they were being observed. It is probable, in fact, that he began to use a stop-watch in secret while yet he was struggling to force his men to increase their production. It is safe to say also that his first observations were not very elemental but became more and more so.

Before long he established what one of his associates calls the "unalterable rule that all time study for rate setting must be done not merely with the knowledge but with the co-operation of the worker." As a matter of fact, Taylor's secret use of his watch was fairly feasible only as long as his object remained simply that of improving the statistics long used in the shop in connection with setting piece-rates for and figuring the labor costs of new jobs.

How he was led from the mere betterment of these statistics into true time study with all its constructive as well as analytical features, is easy to see. As he listed the motions made by his men, he could not well have failed, his mentality being what it was, to observe them *critically* — to question whether they could not be made more deftly and whether they were all necessary. Take any particular motion. If he had not been there with his watch, he would not have been likely to give it a thought; but as he watched the second hand of his watch go around while the worker went through that motion, that motion *loomed up*. All of which is to say that the very process of recording *in detail* the time taken to do work inevitably brings up the question as to whether it is done *efficiently*; that is, whether the same result should not be obtained with less effort, or more result obtained with the same effort.

Obviously such a question can be determined only by experiment; and as Taylor began the experiments which had for their prime object the discovery of false or unnecessary motions he naturally had to select men for the experiments and fully inform them as to the part they would be called upon to play — certainly in the case of all time *study*, as distinguished from mere time recording, secrecy is impossible.[1] It seems, indeed, that Taylor, when asking permission from his " Uncle William " Sellers to do some experimenting, discreetly mentioned only those of the machine or metal-cutting type, and that for a considerable period Sellers was unaware of the time study. In this event, however, Sellers probably was the only one connected with Midvale who did not know of the time study when it first really began, and this " blissful ignorance " in his case was made possible by the fact that he came to Midvale but rarely.

It is certain that in inaugurating his time study Taylor did not have the sympathy of a single soul inside or outside of those works. His most intimate friends just sat back and wondered. Says one of those friends, Theophilus B. Stork:

> I can well remember when, at the Midvale Steel Works, he began what seemed to us all at the time a hopeless and useless undertaking, the ascertaining exactly how long it took a workman to do a given piece of work. Imagine a young cadet of industry, a student just out of the technical school, with a stop watch and a huge diagram before him, stationed by Taylor opposite a workman to note minute by minute, aye, almost second by second, each and every movement.

[1] As he reached this stage, Taylor of course studied each labor operation repeatedly before fixing a standard time for it. While doing this he must have found, as time-study men do today, that the worker frequently took different times to make the same motion or perform one of the units to which the operation had been reduced, and for this very reason had his critical attention drawn to that motion or unit. Since it always must impress the observer that there must be a reason why a man takes different times to do the same thing, the most skilful or deft way is indeed most likely to be discovered through the contrasting times of the same unit of an operation as these are presented in a number of studies of that operation.

Now he takes up a tool; click goes the stop watch, and down on the prepared diagram goes the number of seconds that are required for the movement; and so on, day after day, month after month, until stacks of these diagrams of the time required for the workman to do the simplest act were collected. No wonder many thought the whole work fanciful and its cost of thousands of dollars thrown away.

It was not that there were lacking at Midvale men who appreciated the general idea that if you could find out how long it should take to do a job, you would save endless disputes; but it was thought that in making his minute studies and developing his elaborate records, Taylor again was carrying things to a "crazy" extreme.

To us now there clearly appears in his time study his genius for recognizing that trifles make perfection, or his genius for detail. Such we call it; but in his own philosophy, it was a manifestation, not of genius, but of will. He was likely to be impatient with men who said they had no head for details; he could not help but feel that they simply were too lazy to bother with them.

It would seem that throughout his lifetime it was hard for people both in and out of industry to understand that, regardless of the variety of work done in a shop, the great majority of movements there made are made over and over again, and that when once these movements are standardized, they require no further analysis or timing. Moreover, the whole nature and technic of time study was deliberately and maliciously misrepresented by Taylor's foes. We again quote from the testimony taken by the Special House Committee:

Mr. Redfield. The statement has been made that it is un-American and an indignity for a workman to submit to time study with a stop watch; that it is annoying and makes a man nervous and irritable. To what extent have you any knowledge as to what extent that is true or not?

Mr. Taylor. Mr. Redfield, I think that the average workman, if any man came to him with a stop watch without any previous explanation or understanding and began timing every motion and writing down what he was doing, would become nervous and would be irritated by it. . . . I am very sure that I should be nervous to a greater or less extent if anyone were timing every one of my motions. I would feel that it was a darn mean job while the thing was going on. But, Mr. Redfield, I wish to call your attention to one fact, which is not at all appreciated: Somehow there has come to be an impression in the minds of people who speak and think of scientific management in its relation to time study, that for every workman who is working in the shop there are probably four or five men standing over him year in and year out with stop watches. Let me tell you that in some of our shops there are many workmen who, in the whole course of their lives, never have a stop watch held on them. And that probably the average man would not be timed for more than one day in his lifetime. So that probably one day of the workman's life would sum up the total of this terrible nerve-racking strain which several of the men who have testified before your committee have complained of. Therefore, if any man objects to time study, the real objection is not that it makes him nervous. His real objection is that he does not want his employer to know how long it takes him to do his job.

It would appear also that some people think that when you speak of the scientific, you necessarily are referring to something of hair-line accuracy. Thus when it was brought out in investigations of the workings of time study that, in recording such things as the "percentage which must be added to the actual working time of a good workman to cover unavoidable delays," one must depend largely on common sense, there were not lacking those who declared that that showed up the whole thing as unscientific. Taylor, of course, never dreamed of asserting that there was anything exact about time study in the sense that the sciences of mathematics and music are exact. "The whole subject of time study," he told the Special House Committee, "is only an approximation. There is nothing positively accurate about time study from end to end. All we hope to do through time study is to get a vastly closer approximation as to time than we ever had before."[1]

Somewhere along about 1881 it clearly was presented to him that his problem of getting metal cut in the quickest time involved studying both what his men could do and what the machines could do. Hence his two types of experiments; and it is highly probable, by the way, that his machine experiments, or those which constituted a "study of the art of cutting metals," were to a large extent inspired by what he observed while developing "accurate motion and time study of men." Say, for example, you are timing the motions made by a man in lifting a piece of steel to a planer table, in setting it level and true on the table, and in putting on the stops and bolts. Now he starts the planer, and as it works he, occasionally making adjustments, stands waiting for the machine to finish. Doesn't he wait too long? *Can't the machine run faster? Has the cutting tool been ground to just the right angle?* Such questions, at all events, must have occurred to one like Taylor.

As in the case of all men of great achievement, he accumulated his detractors; and one of their ways of attempting to belittle him was by saying that he was a man merely of the machine shop. If they had said *mainly,* their statement might have been true. This aside, Taylor's friends had justification for believing that if his first and great principle of reducing all work to a science could be applied in a machine shop doing any miscellaneous work, it could be applied to anything. "The development of a science," Taylor himself said, "sounds like a formidable undertaking, and, in fact, anything like a thorough study of a science such as that of cutting metals necessarily involves many years of work. The science of cutting metals, however, represents in its complication, and in the time

[1] As in the case of other features of Taylor's work, the technic of time study has gone on developing, and this improvement, of course, has been in the general direction of getting results more nearly accurate.

required to develop it, almost an extreme case in the mechanic arts."[1]

Nowadays, thanks to Taylor's investigation, the quickest machine or actual cutting time can be readily calculated. In the early 1880's practically the whole art of cutting metals was left to the individual judgment of workmen and foremen, and thus it necessarily had no basis other than rule of thumb or empiricism. In raising it to an art resting on scientific principles Taylor had to work from the bottom up, and here indeed was an herculean task.

[1] Testimony before Special House Committee.

CHAPTER IV

BEGINNING HIS METAL-CUTTING INVESTIGATION

NATURALLY he could not foresee what was involved in his course. If he could have had this knowledge, it is improbable that even such a stout-hearted young man as he would have embarked upon it so blithely. Surely Providence has a cunning little way of leading us on! We say that there is the goal; but when we get there, we find it has receded to a point we never would have attempted to reach from our original starting point, and so it continues.

> The first thing we wanted to do [Taylor said] was to settle the question which every mechanic had supposed was the essence of the whole matter, and that was, what was the proper angle for tools, what was the proper clearance angle, what was the proper side slope, and what was the proper back slope.[1]

It is not strange that Sellers was reluctant to consent to these experiments. In attempting many years before to adopt for his own machine-building plant standard shapes and angles representing compromises on those used by the most experienced machinists, he had taken a step away from the old philosophy of leaving all the small details of the shop to the judgment of the workmen; but it was only a tentative step, and while it was away from the old, it hardly was a step to-

[1] Testimony before Industrial Relations Commission. An uncorrected report of this testimony is printed in *Industrial Relations*, Vol. I, Government Printing Office, 1916.

wards the new philosophy that all the small details should be subjected to scientific investigation.

It is probable that in at length consenting to Taylor's experiments, Sellers was influenced, not only by the consideration that his young Midvale foreman was entitled to some reward for already having increased the production of the machine shop, but also by the well-nigh matchless Taylor enthusiasm. Be that as it may, it is extremely unlikely that there was then in industry another chief executive who would have given young Taylor any encouragement at all.

In all good faith Taylor represented to Sellers that in the determination of those angles lay the essence of the whole problem as to the speed at which cutting tools could be run, and he was sure he could get to the bottom of the thing in six months. "If," said Taylor, "it had been understood that the experiments would take longer than six months, permission to make them never would have been granted."

For more reasons than one he was lucky to be at Midvale.

> We happened to have [he said] a great pile of uniform metal to work on. We had 2,000 tons of locomotive tires — plenty of them in the scrap heap. That was metal of a uniform type. So we had plenty of splendid metal to work on, and we had the only machine in Philadelphia on which we could make those experiments. So we started men to work right along and varied the cutting angles, and kept a record of what we did.[1]

And this is what happened:

> For six months those experiments went on, and at the end of that time we had arrived at the extraordinary fact that it did not make much if any difference what those cutting angles were as far as speed went. We got only negative results.

To be sure, the experiments proved that the angles of cutting tools have an important effect on their ability to stand

[1] *Ibid.*

up under use without breaking; nevertheless, Taylor had to confess that, as far as the main object of the experiments was concerned, they had failed.

At this intelligence, so Taylor testified, Sellers laughed mockingly, and said: "That shows up the whole thing. There is a lot of money thrown into the fire." But our young experimenter was nothing daunted. "That's all right, Mr. Sellers," he rejoined, "but let me show you that we have uncovered a gold mine of information. We have got to the top of a gold mine, and I want to show you what it is." Again the irresistible enthusiasm.

> When [said Taylor] I was able to show Mr. Sellers the information we had already got, and that we were on the track of getting, which would enable our men to do faster and better work, he said: "Go right ahead and spend that money."

His own personal friends repeatedly warned him that he was attempting the impossible; and if, apart from Sellers, everyone at Midvale, so far from having any sympathy with his experiments, was actively opposed to them, it was not without reason.

> Mr. Sellers, in spite of the protests which were made against the continuation of the work, allowed the experiments to proceed; even, at first, at a very considerable inconvenience and loss to the shop. The extent of this inconvenience will be appreciated when it is understood that we were using a 66-inch diameter vertical boring mill, belt driven by the usual cone pulleys, and that in order to regulate the exact cutting speed of the tool, it was necessary to slow down the speed of the engine that drove all the shafting in the shop; a special adjustable engine governor having been bought for this purpose. For over two years the whole shop was inconvenienced in this way, by having the speed of its main line of shafting greatly varied, not only from day to day, but from hour to hour.[1]

[1] *On the Art of Cutting Metals*, p. 34.

It was not long before the experiments began to pay for themselves by yielding practical results of immediate value. This may seem to exemplify the habit of fortune in smiling upon the brave; but as a matter of fact it is readily explicable on the basis that, no matter what the field in which a scientific investigation is made, it almost invariably will show that, as Gantt put it, "the usual way of doing a thing is the wrong way."

The first laws developed for cutting metals were crude and contained only a partial knowledge of the truth, yet this imperfect knowledge was vastly better than the utter lack of information or the very imperfect rule of thumb which existed before, and it enabled the workmen, with the help of the management, to do far quicker and better work.[1]

This meant that, very early in his experimental cutting up of metal into chips, Taylor proved the unsoundness of the philosophy of leaving workmen to select their own methods with such help as they can get from their foreman. Even if, as Taylor pointed out, workmen had an education which gave them the "habit of generalizing, of everywhere looking for laws," they "lack the time and the opportunity for developing these laws." Moreover, when workmen are left to devise their own methods, they must always be handicapped by being obliged to use such tools and machines as the management provides. It is to be considered also that workmen form the largest element in the mass of humanity, and that the mass does not look ahead, has little or no concern for progress, and represents, save when stirred to action by some exceptional man, a great inertia or resistance to change.

After many years of close personal contact with our mechanics [wrote Taylor], I have great confidence in their good judgment and common sense in the long run, and I am proud to number many of

[1] Testimony before Special House Committee.

them among my most intimate friends. As a class, however, they are extremely conservative, and if left to themselves their progress from the older toward better methods will be exceedingly slow.[1]

At the same time, Taylor was far from failing to recognize how often the characteristic inertia of the mass is also found in the management. He had too many sad experiences with managers to escape this recognition. It was his mature judgment that the philosophy of "initiative and incentive" was, in the main, the lazy manager's philosophy; the management could talk all it pleased about the workmen being supposed to be expert in their trade, but the real reason for putting the details up to the workmen was likely to be that the management was disinclined to assume the duties, burdens and responsibilities that naturally belonged to it.

The most important discovery of *immediate* value that Taylor made in the early stage of his experiments was that "a heavy stream of water poured directly upon the chip at the point where it is being removed from the steel forging by the tool would permit an increase in cutting speed, and therefore in the amount of work done, of from thirty to forty per cent." When, all lit up with enthusiasm, he went to Sellers with this discovery, he found his "Uncle William" incredulous. "It was pretty hard to make him believe that truth." However, Sellers at length said: "How can we get that water to our machines?" And Taylor replied: "Well, we can't do it in our present shop."

This was in 1883. Probably the building of a new shop already had been projected, but apparently the discovery about the water proved to be the determining factor. At all events, in the latter part of 1883, Taylor was authorized to design and build a new shop; and this unfolded for him several new and very important opportunities in connection, not

[1] *On the Art of Cutting Metals*, p. 53.

only with his experiments, but also, as will appear later, with the development of his general system.

We read that in the new shop, which was opened in 1884, each machine was " set in a wrought iron pan in which was collected the water (supersaturated with carbonate of soda to prevent rusting) which was thrown in a heavy stream upon the tool for the purpose of cooling it. The water from each of these pans was carried through suitable drain pipes beneath the floor to a central well from which it was pumped to an overhead tank from which a system of supply pipes led to each machine." And Taylor added: " Up to that time, so far as the writer knows, the use of water for cooling tools was confined to small cans or tanks from which only a minute stream was allowed to trickle upon the tool and the work, more for the purpose of obtaining a water finish on the work than with the object of cooling the tool; and, in fact, these small streams of water are utterly inadequate for the latter purpose." [1]

When the French scholar Le Chatelier came to read *On the Art of Cutting Metals*, he referred to the discovery about the value of keeping the nose of a tool wet as one of the simple but highly important facts stated by Taylor which were " so easily verified that one is justified in being astonished that they are not known to everybody." But, as bearing on the inertia of management, here is this further quotation from Taylor's paper: " So far as the writer knows, in spite of the fact that the shops of the Midvale Steel Works until recently [1906] have been open to the public since 1884, no other shop was similarly fitted up [with water supply for the machines] until that of the Bethlehem Steel Company in 1899, with the exception of a small steel works which was an offshoot in personnel from the Midvale Steel Company." In the address he made in Cleveland just before his death, he said: " Gentlemen, think of it! only one machine shop in

[1] *Ibid.*, p. 37.

twenty years followed that, namely, the practice of pouring water on tools. It was explained to manufacturers, but the average man said, 'Oh, hell, what's the use.' There is the answer."

One of the other great opportunities which the building of the new shop gave him was that of beginning the experiments with belting that, extending over a period of nine years, furnished him with material for a paper which, presented to the A.S.M.E. in 1893, drew from Henry R. Towne, who himself had experimented with belting, this comment:

> The present paper is modestly entitled "Notes on Belting," but could be more fittingly described as a treatise on the practical use of belts. Its thirty-four pages contain more new and useful information than is found in any other paper that has come to my knowledge.

In this paper Taylor said that while working as foreman he "became convinced that the belts, which were laced according to the ordinary rules, were a great source of loss to the company — not so much from the cost of the belting and the labor of lacing as from the incidental delays to the machines and the diminished output of the shop resulting therefrom." However, what directly led to his undertaking his belting experiments was the trouble he had in maintaining the tension of the belt used in driving the boring mill for his metal-cutting experiments. After investigating the trouble, he concluded: "(1) that belting rules in common use furnished belts entirely too light for economy, and (2) that the proper way to take care of belting was to have each belt in a shop tightened at regular intervals with belt clamps especially fitted with spring balances," which permitted each belt to be "re-tightened each time to exactly the same tension."[1] But never could he rest with conclusions that had not been thoroughly tested, and neither was he content to resort to experimenting

[1] *On the Art of Cutting Metals*, par. 111.

until he had looked up what already had been done. He found that all the previous experiments in this field that were worth while had been of "short duration," and "very little information could be obtained as to the cost of maintenance of belts, or in regard to the interruptions to manufacture from belting."[1] Thus when he built his new shop

> . . . about half the belts in the shop were designed according to the ordinary rules and the other half were made about two and one-half times as heavy as the usual standard. This shop ran night and day. The belts were in all cases cared for and retightened only upon written orders sent from the shop office; and an accurate record was kept through nine years of all items of interest concerning each belt, namely: the number of hours lost through interruption to manufacture; the number of times each belt interrupted manufacture; the original cost of each belt; the detail costs of tightening, cleaning, and repairing each belt; the fall in the tension before requiring retightening; and the time each belt would run without being retightened.[2]

His exhaustive experiments demonstrated not only his original hypothesis, but also many other facts of great service to industry; and as he himself said, "this belting experiment illustrates again the good that often comes indirectly from experiments undertaken in an entirely different field."

Returning now to his problem pertaining to machine time, we find that he eventually discovered that it resolved itself into that of devising some practical means of accurately answering these two questions which arise every time a piece of work is put into a metal-cutting machine: (1) At what rate should the metal be fed to the tool? (2) At what speed should the tool be run?

"These questions," he testified, "sound so simple that they would appear to call for merely the trained judgment of any

[1] *Notes on Belting*, par. 5.
[2] *On the Art of Cutting Metals*, par. 112.

good mechanic." But what he gradually discovered, as he continued to resolve his problem into its elements, was that "the answer in every case involves the solution of an intricate mathematical problem in which the effect of twelve independent variables must be determined." [1]

A classic example, this, of the scientific method of deliberation and analysis, so that you may know exactly what you don't know and must discover. It all comes down to asking yourself the *right questions;* and it was a bit of Sellers' wisdom, we believe, that if only you do this, you usually will find that the answer is right at hand. True, this was far from being the case with Taylor's machine-time problem, but here the circumstances were most decidedly unusual. It was not merely that it was a problem of many complications. "The difficulty of Mr. Taylor's problem," says Gantt, "can be understood only when it is known, not only that he had no precedents and no standards to guide him, but that even the methods of devising the standards he needed had, when he began his experiments, to be developed."

The fact was that in this field Taylor searched in vain for a record of any previous experiments, the indications being that no such investigation as his ever had been conceived of, much less attempted, before in this or any other country.

[1] In his paper *On the Art of Cutting Metals* (page 32), Taylor listed his variables as follows: "(a) the quality of the metal which is to be cut; (b) the diameter of the work; (c) the depth of the cut; (d) the thickness of the shaving; (e) the elasticity of the work and of the tool; (f) the shape or contour of the cutting edge of the tool, together with its clearance and lip angles; (g) the chemical composition of the steel from which the tool is made, and the heat treatment of the tool; (h) whether a copious stream of water or other cooling medium is used on the tool; (j) the duration of the cut, *i.e.*, the time which a tool must last under pressure of the shaving without being reground; (k) the pressure of the chip or shaving upon the tool; (l) the changes of speed and feed possible in the lathe; (m) the pulling and feeding power of the lathe." Barth, who completed these metal-cutting experiments, has made an improved statement of the variables, but for the purpose of this biography Taylor's should suffice.

CHAPTER V

LIMIT OF METAL-CUTTING PROGRESS AT MIDVALE

LOOKING ahead, we find that Taylor was destined to pursue his metal-cutting investigation long after he left Midvale — that, in fact, he continued with it, off and on, over a period of a quarter of a century. Not until 1906 did he publish anything about it. However, his high-speed steel, which was one of the by-products of this investigation, was exhibited at the Paris Exposition of 1900, and apparently as a direct consequence of the sensation it made in Europe, some metal-cutting experiments then were undertaken there.

In 1901, a committee of the Verein Deutscher Ingenieur (Society of German Engineers) did some experimenting in association with the managers of some of the larger engineering works in Berlin. Then, covering a period of six months in the years 1902 and 1903, experiments more elaborate than the German were made at Manchester, England, by eight manufacturing firms acting jointly with the Manchester Association of Engineers and the Manchester Municipal School of Technology.

Neither these German nor these English experiments remotely approached in exhaustiveness the ones that Taylor undertook single-handed, so to speak. The English, though going into the thing more deeply than the Germans, limited themselves to about 220 experiments. Taylor made about 40,000. But the really noteworthy thing is the difference in *quality*.

From some rough notes Taylor jotted down apparently for an address, we quote the following:

> When starting an experiment in any field (particularly rule of thumb) question everything; question the very foundation upon which the art rests; question the simplest, most self-evident, most universally accepted facts; prove everything.
>
> Desirability of going all the way to the limit in experimenting. Only one variable at a time. Difficulty in getting down to the real variable. Great temptation to experiment with more than one variable in order to get quick results.
>
> Perhaps the greatest difficulty of the experimenter is to hold the surrounding or accompanying conditions constant and uniform while one variable is experimented with; that is, to standardize surrounding conditions. Continual watchfulness and re-standardization of surrounding conditions necessary. If possible have two or three checks.

The Germans, despite the reputation of their race for thoroughness, took the easier course. So did the English. At Manchester, we believe, the joint effect of four or five variables was studied. Yes, and this easier way also was followed when, in 1905, some metal-cutting experiments were conducted by two professors at the University of Illinois. Only Taylor took the slow, patient, difficult course, and so reached conclusions that were absolutely sound. This though he had to conduct his experiments amid the every-day work of the shop, and was, at least after he left Midvale, under a painful necessity which he referred to in his notes as follows:

> The greatest difficulty in commercial life is to get the opportunity to successfully carry out the experiment; frequently more ingenuity is required in providing the opportunity than in making the experiment itself.
>
> Special ingenuity is required to see how experiment can be made profitable to employer in comparatively short time. Necessity in many cases for beginning at the wrong end of the experiment to furnish a convincing object lesson to your employer.

Illustrative of the saying that science is but sublimated common sense is the fact that Taylor's truly scientific course represented the carrying out of the homely old adage, "One thing at a time." That he was inspired to take this course from the beginning, undoubtedly was due to the influence of his "Uncle William" Sellers.

However, as he had to develop even the methods of devising the standards for measuring the effect of each of his variables upon the cutting speed, it is not astonishing that his first standards proved wrong or inadequate. For example, it was not until after fourteen years that he discovered that the "best measure for the value of a tool lay in the exact cutting speed at which it was completely ruined at the end of twenty minutes." Another fact not surprising under the circumstances is that, especially at the beginning, he occasionally failed to hold all his variables constant except the one he was studying, and that he from time to time failed to "record some of the phenomena considered unimportant at the time, but which afterward proved to be essential to a complete understanding of the facts"; so that again and again he had to "go more carefully over the ground previously traveled."

Perhaps it may be considered strange that Sellers, a builder of machine-tools as well as a man of thoroughly scientific instincts, had never himself studied the question of the proper speeding of these machines. The answer, apparently, is to be found in the then prevailing custom of leaving all such things to the judgment of workmen, and the inhibiting effect that custom is likely to have on the best of us. The custom of leaving the handling of tools to the judgment of workmen was, of course, a relic of the old days when tools were few and extremely simple; and it is notorious that customs in general have a habit of persisting long after changed conditions have made them untenable.

This fact is that manufacturers of machine-tools in general were content to remain ignorant of the speeds at which their machines should be run long after Taylor had finished his metal-cutting study and published it.

I am well within the limit, gentlemen, in saying [he testified in 1912] that not one machine in twenty in the average shop in this country is properly speeded. This may seem incredible, and yet I make the statement with a great deal of confidence, because the Tool Builders' Association of the United States — the men who manufacture the machine tools of this country — last spring asked me to address their annual convention. I told them, just as I have told you, that not one in twenty of the machines in their shops was properly speeded and I added, "You gentlemen know whether I am telling the truth or not, and I challenge anyone who thinks I am wrong in this statement to go into his own shop, and let me show him how far wrong the speeds of his machine are." Not a man took up this challenge.

With his habit of scientific investigation, he was destined to prove repeatedly that all kinds of manufacturers are likely to have only a superficial knowledge of the capabilities of their own products and the way they should be handled; his most vivid showing up in this respect having for its victims, as we shall see, the manufacturers of tool steel.

Though readily explicable on a basis other than that of luck, it indeed was fortunate for him that his metal-cutting investigation early yielded by-products having immediate practical value, since he scarcely made any progress with his main investigation during the first five years he struggled with it.

To begin with, his study of the effect of each of his variables upon the cutting speed involved finding for the laws thus discovered mathematical expressions which were "so simple as to be suited to daily use." As early as 1883 he developed formulae which gave expression to the "broad laws" he had discovered at that time, and "fortunately these formulae were of the type capable of logarithmic expression and therefore suited to the gradual mathematical development extending through a long period of years." However, he never developed himself very highly in mathematics. "Taylor," says Barth, "learned his mathematics quickly, and to a large extent forgot them quickly." That he did not have the time to go on with this science should be clear from what has been set forth of his undertakings in general, able though we are only to indicate, and that imperfectly, the totality of the things that this highly charged young man took upon himself. Moreover, he had the true executive instinct of confiding to others as much detail as possible and of enlisting the coöperation of those with forms of ability supplementing his own. Thus, along about 1884, he asked permission of Sellers to employ a young technical man to help him, and because of the results he already had obtained, Sellers consented.

The first man so employed was George M. Sinclair, a graduate of Stevens Institute. Sinclair continued at Midvale for about three years. Under Taylor's direction he worked out the first "simple formulae which expressed with approximate accuracy the effect of each of the numerous variables upon the cutting speed." But now the greatest difficulty arose.

After these laws had been investigated [Taylor told the Special House Committee] and the various formulae which mathematically expressed them had been determined, there still remained the difficult task of how to solve one of these complicated mathematical problems quickly enough to make this knowledge available for every day use. If a good mathematician who had these formulae before him were to attempt to get the proper answer (*i.e.*, to get the correct cutting speed and feed by working in the ordinary way), it would take him from two to six hours, say, to solve a single problem; far longer to solve the mathematical problem than would be taken in most cases by the workman in doing the whole job on his machine.

Thus a task of considerable magnitude which faced us was that of finding a quick solution of this problem, and as we made progress in its solution, the whole problem was from time to time presented by me to one after another of the noted mathematicians in this country. They were offered any reasonable fee for a rapid, practical method to be used in its solution. Some of these men merely glanced at it; others, for the sake of being courteous, kept it before them for some two or three weeks. They all gave us practically the same answer, that in many cases it was possible to solve mathematical problems which contained four variables and in some cases problems with five or six variables, but that it was manifestly impossible to solve a problem containing twelve variables in any other way than by the slow process of "trial and error."

This difficulty was not overcome until 1899,[1] when Taylor was at Bethlehem; but some progress was made at Midvale, where, as Taylor wrote:

The first mathematical solution of the problem was made by Mr. G. M. Sinclair, who devoted, as the writer remembers, a year or more of consecutive work to this end with the help and advice of the writer. This solution was accomplished by means of overlying curves plotted on ordinary cross-section paper, with which we were able to work out laboriously and exceedingly slowly, for each particular lathe or planer, a set of tables which could be used for most of the conditions met with in ordinary work. This method was, however, so exceedingly slow and laborious as to make it far from generally useful.[2]

When Sinclair gave up this work in 1887, he recommended that there be employed as his successor one of his Stevens classmates named Henry L. Gantt. Thus in this year there came together two young men (Taylor was then thirty-one and Gantt twenty-six), who, though they were temperamental

[1] According to Mr. Barth, the mathematical problem that from the beginning confronted Taylor and his co-workers was essentially this: "how to determine that feed and speed of a machine that will at the same time utilize a maximum of the power the machine is capable of developing at that speed, and the ability of the cutting tool itself to stand up to the work an economical length of time before giving out, on a piece of work of a certain degree of hardness, and of a certain diameter to be reduced to a certain smaller diameter."

[2] *On the Art of Cutting Metals*, p. 277.

opposites in some respects, formed a professional association that was destined to continue for many a year. Born in 1861 on a farm in southern Maryland, Gantt attended a school near Baltimore from 1873 to 1878; was graduated from Johns Hopkins University in 1880 with the degree of A.B., taught school for the following three years; and then, in 1884, obtained his degree of M.E. at Stevens. We are told that at the beginning of his work at Midvale, he won Taylor's confidence by promptly solving a mathematical problem which had baffled both Taylor and Sinclair; Gantt reaching his solution by emphasizing the coincidences and minimizing the differences, and so tracing out a law, a method highly characteristic of his fluent, adaptable nature.

After Mr. Sinclair left the problem [Taylor continued in his metal-cutting paper], Mr. H. L. Gantt devoted a year or more of his time almost exclusively to its solution, and it was during this period that we substituted curves laid out on logarithmic paper for the direct curves laid out on ordinary cross-section paper. As a result of this work, we obtained a logarithmic sheet upon which both diagrams and figures were used to represent the laws, and by means of an elaborate cross slide, upon which further elements of the laws were entered, we were able to make a more rapid and much more direct solution of the problem. This was done, however, by the method of trial and error, but by means of this crude sliding table we were able to make quite rapid approximations to the proper working conditions.

Testifying in 1912 before the Special House Committee, he said:

The Midvale Steel Works, my old establishment, are still using the tables which Mr. Gantt and I developed there for running their machines, instead of the more modern and far more efficient slide rules developed after we left there. These tables were the limit of the mathematical solution of that problem when we left Midvale in 1889.

CHAPTER VI

FROM EXPERIMENTATION TO STANDARDIZATION

IN THE notes he sketched for a paper on experimenting, we read further:

> Our experiments have been of two kinds: first, the reduction of the control and operation of machines from rule of thumb to science, and, second, the examination and standardization of human actions and work with relation both to maximum efficiency and maximum speed.
>
> In changing a machine from rule of thumb both in design and in running to a science, first note carefully all the defects of the machine; that is, all things likely to get out of order and cause bad work or stoppage. Next chase down and analyze each defect and note the effect that it has upon the time problem; that is, upon the quantity and the quality of the output. Then centre upon the most important defect and correct it; then follow up in regular order of importance.
>
> Next study all the elements as they effect the speed and output, whether they are connected with the machine alone or with the man and the machine combined; then find the one or more elements which limit the speed of output; centre on the most important, and correct them one after another. This generally involves a combination of study of the man with the machine and involves in many cases minute time observations with the stop watch.

His time study and his metal-cutting investigation were indeed closely connected and interwoven; having for their common purpose the cutting down of time to the minimum consistent with the doing of good work. In like manner his belting experiments, which were an offshoot of his metal-cutting investigation, had mainly for their purpose the saving of time through the avoidance of delays and interruptions.

Incidentally we can see this purpose as the general cause of the outpouring of his ingenuity in mechanical invention. His great steam-hammer was designed to work faster than any other thing of its kind. He built a new chimney on top of an old one to save "a loss of at least one or two months in time." And here is the machine-tool table he invented early at Midvale, the table being the part of the machine on which work is place to be operated on. It usually takes much time to set the work on the table and secure it by clamping, and Taylor just could not stand the spectacle of the machine standing idle while this was being done. So what he invented was a "false" table, or one that was separable from the machine; this, of course, permitting new work to be made entirely or nearly ready on a table while the machine continued busy. Then his study of cutting tools led him to invent a new tool holder further to expedite the work. This, roughly described, enabled a tool to be held in various positions to correspond to various surfaces, and thus made it possible for one tool to take the place of several of different shapes.

In writing about Taylor's metal-cutting investigation at Midvale, Barth says:

> This implied, besides the study of the possibilities of the cutting tools themselves, also a study of the properties of each machine dealt with, in a manner that had probably never been undertaken or thought of before. Through these studies of the machine-tools themselves, Mr. Taylor was able to furnish greatly improved detailed specifications for new machines to be purchased, so that very early in his career he also exerted some influence on the machine-tool building industry, of which I, as draftsman at the works of William Sellers & Company, was made cognizant as far back as the early eighties.[1]

[1] Barth's "Supplement to Frederick W. Taylor's 'On the Art of Cutting Metals;'" *Industrial Management*, September, 1919.

Still another investigation he started at Midvale had for its object the finding of " some rule, or law, which would enable a foreman to know in advance how much of any kind of heavy laboring work a man who was well suited to his job ought to do in a day." His first step was to " look up all that had been written on the subject in English, German, and French," and what he found was that

> . . . two classes of experiments had been made: one by physiologists who were studying the endurance of the human animal, and the other by engineers who wished to determine what fraction of a horse-power a man-power was. These experiments had been made largely upon men who were lifting loads by means of turning the crank of a winch from which weights were suspended, and others who were engaged in walking, running, and lifting weights in various ways. However, the records of these investigations were so meager that no law of any value could be deduced from them.[1]

His purpose was to discover, not what a man could do " on a short spurt or for a few days," but " the best day's work that a man could properly do year in and year out and still thrive under." Two first-class laborers, to whom were paid double wages, were selected for these experiments, and for weeks Taylor's time-study man recorded every element connected with their work which was " believed could have a bearing on the result." At Midvale these experiments " resulted in obtaining valuable information," but for the development of the law " governing the tiring effect of heavy labor on a first-class man," Taylor again had to wait until he went to Bethlehem and there had the assistance of Barth.

He deliberated and analyzed and investigated and experimented all along the line. For the qualities of equipment and materials he refused to take the salesman's or the manufacturer's word. When electric lamps were installed at his

[1] *The Principles of Scientific Management*, p. 54.

boring mills, he kept records of the consumption of current of several varieties so that he might determine the most economical.

A thing to be noted about his deliberation is that he did not wait until it was all nicely polished off before he proceeded to experiment. As he was a fallible human being, and so could not determine from the beginning all the knowledge he must seek, his deliberation naturally was subject to a continual process of correction and extension. There, for example, was his original thought that the essence of the problem as to the speed at which cutting tools could be run lay in their shapes and angles; after months of experimenting he learned that this was only one of twelve elements in his speed problem. This illustrates that with any scientist deliberation probably is as much the effect of experimentation as the cause, the one reacting on the other.

In his later years Taylor came to exclaim against the folly of trying to make sure you are *entirely* right before you go ahead. It was his wisdom that you can safely go ahead if only you are sure that your general direction is right — and you should not spend too much time trying to make sure even of that; you at least can proceed with caution. "You learn more with a poor start," he said, "than with no start at all." Evidently this principle of learning through acting governed him as far back as his days at Midvale. It is to be observed, however, that his early-established rule of doing no experimenting himself until he had exhausted all available means of learning what experimenting already had been done in the field concerned was one from which he never deviated.

As his time study or his metal-cutting investigation made it necessary for him to experiment at or with various machines, these machines were withdrawn from the regular work of the shop. This signifies that if he did not actually set up a laboratory, he did what amounted to the same thing. Certainly

Form X-1[illegible]3

Time Note.

Machine Shop, ... [illegible]

Name, ...

Do all work on Tire No ....

As per Standing Order No. ....

Inside Flange Tires.	Mac. No.	TIME	RA
Rough face front edge,			
Finish bore front,			
Rough bore front,			
Rough face front, I. S. F.,			
Cut out fillet,			
Rough bore front, I. S. F,			
Rough face back edge,			
Finish bore back,			
Rough bore back,			
Rough face back, I. S. F.,			
Cut out fillet,			
Cut recess,			
Rough turn tread,			
Finish turn tread,			
Rough turn flange,			
Finish turn flange,			
Cut fillet of flange,			

Total time,

Time out, ... Total Am't earned, ...

Time in, ... Signed, ...

AN EARLY TAYLOR FORM

A "time note" for machine work, in which were combined certain features of his later work-order slip and instruction card. Midvale, about 1885

TIME-NOTE.

Machine Shop, 188

Order TIME

Name.

WORK DONE.	No.	Rate in cents.	Amt.	Time
Enter tires in records from standing orders,		0.25		
Enter tire time-notes on white sheets,		0.5		
Post tire records from time-notes,		0.3		
Enter weights of tires on white sheet and add up weights of tires from tire mill,		0.3		
Post wages earned by men on mills and fix bonus,		0.2		
File and put away records of finished tires,		5.0		
Assort tire records and put in final file,		10.0		
Make out standing orders I. S. F. tires,		1.5		
Make out standing orders ordinary tires,		0.5		
Enter miscellaneous time-notes on white sheet,		0.3		
Post miscellaneous time-notes in records,		0.85		
Check off white and yellow sheets from register for men, to see if all time is correct,		5.0		
Enter axles (standing orders) in records,		0.3		
Post records of axles from time-notes,		0.3		
Take out standing orders to boxes,		5.0		
Make out standing orders for I. S. F. tires,		1.5		
Make out standing orders for ordinary tires,		0.5		

Time out Total time.

Time in. Total amount earned.

I have inspected the above work and find that it is all done as per order.

Signed,

AN EARLY TAYLOR FORM

Showing that Taylor early standardized clerical operations. Midvale, about 1885 his was the laboratory *method*. However, nothing like his laboratory ever had been known before in the sense that its purpose was to determine best shop ways with a view to their standardization. And this brings us to that great principle of his which during his lifetime few people, whether apart from industry or of it, were able to grasp.

From the very outset his principle of standardization appears. He found that the big obstacle to getting the maximum production was the then universal difficulty of rewarding workers equitably according to their accomplishment, and deliberation showed him that the bottom of this difficulty was the fact that management had " no proper standards for a day's work." Thus it was really to establish proper *standards of accomplishment* (and so be able to set equitable piece-rates) that he began his experiments.

Now, there are jobs where the difficulty of maintaining the desired quality of work is so great that the time element is comparatively negligible, but they are the exception which proves the rule that, because of the relation between speed and economy, a proper standard of accomplishment is fundamentally one of speed or of the time needed to produce work of the desired quality. Hence Taylor's " laboratory " was fundamentally concerned with determining standard times. And that this was a problem possible of solution only by Taylor's method of job analysis should be clear when it is considered that you cannot determine with accuracy the total time a job should take until you resolve it into its elementary operations and time these. Once having determined these elementary times, however, you have data for any new jobs that may come into the shop, since all jobs simply represent different combinations of the same elements.

But there is the fact that the time even an elementary operation should take all depends upon the *way* it is performed. This means that to determine the quickest times for adoption as standard, Taylor had to determine the best ways. How could he have done this save through his method of motion study? So there in the "laboratory" was the young man he employed to specialize in this study and the first-class workman who was selected to coöperate with that young man; these two experimenting with all the small details pertaining to the handling of materials, tools, and machines — the lifting to the machine of the metal to be cut; the putting of such tools as drills and reamers into the machine; the measuring with calipers, gages, or scales; the starting of the machine; the changing of the feed or speed; the adjusting of various parts of the machine.

And in the meantime there was Taylor conducting with the help of Sinclair and Gantt the experiments necessary to determine what the actual cutting time of the machine should be. True, he did not get very far with this problem at Midvale; nevertheless, he there succeeded in tracing out laws and getting formulae and tables which, though crude in the light of the ultimate development, enabled him early to establish standard combinations of feed and speed for certain operations such as the boring and turning of steel tires for locomotive wheels, the net result being a marked reduction in the machine time. And this illustrates, by the way, that the one best way of doing a thing is always relative to time and place, or the existing stage in the development of the art.

But now let us fix our attention on those certain operations. For them Taylor not only had the data which enabled him to determine what the machine time should be, but also the data yielded by his motion study which enabled him to determine what the handling time should be.

So far, all very well. But it is to be observed that these data were developed under laboratory conditions. All the conditions were *under control*. Both the machine and the belting which delivered power to it had been brought up to standard condition and kept there. The cutting tools had been of the same quality of steel, had been subjected to uniform tempering, and had been ground to the same shapes and angles. Likewise the tools used for setting and holding the work in the machine and for measuring it had been of a certain kind and had been kept in a uniformly good condition. Moreover, these tools always had been on hand as wanted, and the same thing was true of the metal which was cut. Finally, there is the fact that the workmen who had coöperated in the time and motion study had been picked out as first-class men for the particular jobs studied, and also had been under control in the sense that, by the offer of an extra wage, they had been induced faithfully to carry out the detailed instructions.

Obviously, then, as Taylor wished to make practical shop use of data developed in his "laboratory," *he had to exercise in the shop the same control he had exercised in the laboratory.* So now were thrust upon him further problems in standardization as compared with which those involved in determining best ways were simple.

First of all, he had to standardize all the shop conditions — bring them up to the same standard that had obtained in his "laboratory." This made it necessary for him to take the tool grinding and dressing out of the hands of the individual workmen; and as there must be not only standard cutting tools but also standard bolts, clamps, dogs, calipers, gages, scales, dividers, etc., and all these tools must be on hand when wanted so that the workmen would not lose time chasing them up or be forced to resort to tools other than standard, Taylor had to establish a tool room for their systematic care, storage, and issuance. And it also was necessary for him to develop standard practice for such things as caring for the belting and oiling the machines. Certainly it was not until all this standardization work was done that he could begin to make proper use of his metal-cutting and motion-study data.

But just how could he make use of these data? Plainly it involved getting the right materials and the right tools in the right condition to the right man at the right machine with the right instructions *at the right time.* All causes for delay must be guarded against. As far as possible, the flow of work must be continuous. Therefore, *all the work of the shop had to be carefully planned in advance.*

But there was the matter of the instructions. Just as Taylor had found that you cannot determine with accuracy the total time a job should take until you resolve it into its elementary operations and time these, so he now found that to get the job done in that time, he would have to list for the benefit of the workmen the elementary operations that were necessary and the time each should take; which is to say he found that he would have to give his men *detailed instructions in writing.*

It is well known to all executives that it is one thing to give employees instructions and quite another thing to get them to follow the instructions faithfully. And these instructions of Taylor's called for exceptional work — not only for greater continuity of effort but also for a higher order of attention and watchfulness. They thus ran counter to the average man's very human disposition to take things easy. They, in fact, called for a marked and *permanent* change in his habits. Could Taylor, then, have *forced* his men into following his instructions? The fact is that if only because his long fight with his men had taught him a sharp lesson in the limitations of force, he had no idea of attempting such a thing.

We have seen that when he selected workmen to participate in his motion study, he had to enlist their coöperation, their *good will.* Plainly the same principle held good when it came to getting men to work the way the motion study showed they should work. It was not so much a matter of getting them to work harder as of getting them to work *better,* to make all of their motions tell.

Form X-201.

TIME NOTE.

Engineer's Office, M. S. Co., ... 188

To Engineer .... Order. Porter Allen Engine.

Name .... Time ....

Attend to running Porter Allen Engine, and oiling the same. Oil shafting in Tire Mill annex, and in Hammer Shop to first Tumbl... bearing Hanger for O. H. Crane. Oil wire rope pulley between th... two large wire rope pulleys. Oil No. 1 Hammer Cranes and shafting driving same, and also all shafting connected with the Bending Machine and Fan. Keep all of the above machinery clean, and the finished parts polished, as per Standing Order No. ....

Time out.

Time in.

Signed, ...

AN EARLY TAYLOR FORM

Showing provision for the maintenance of standard conditions. Midvale, about 1885

Form X-219.

Report on Adjustment of Tables of Boring Mills.

Machine Shop 188

Mr. Taylor:

I have this day examined the tables of the following Boring Mills, and find them adjusted as stated below.

No. of Mill.	Table, high or low.	Man running the Mill.	Foreman in charge of Mill.	Table set right or not.

Signed

AN EARLY TAYLOR FORM

Showing provision for the maintenance of standard conditions. Midvale, about 1885

Even then, as Taylor had induced men to coöperate in his experiments by offering them an extra wage, so he now offered them an extra wage for following his detailed instructions for the doing of the every-day work of the shop. The principle was that of *exceptional or extra-ordinary wages for exceptional or extra-ordinary work.* If it was a straight engineering proposition, it also was a just one, and for this latter reason alone Taylor would have adopted it, old-fashioned righteousness being a part of his heritage.

From the beginning, apparently, he had foreseen that, as he determined what his men ought to be able to do with their equipment and materials, he could pay them higher wages permanently. This, indeed, was one of his principal objects. His instinctive belief all along had been that it was for him as a manager to see, not how little he could pay his men, but how much.

Now, as far back as Adam Smith's *Wealth of Nations* (1776) it had been felt that there is a fallacy in the idea that the less there is paid to labor, the less will the product cost; and while in the 1880's it still was far from common for managers to be far-sighted enough to grasp this, more and more were beginning to realize that workmen will not do an extra-ordinary day's work for an ordinary day's pay. However, all those who had been paying extra-ordinary wages had done so in accordance with the philosophy of "initiative and incentive," and it will be seen how different from this Taylor's action became; he paid extra-ordinary wages, ultimately to stimulate the wormen to do more or better work, but immediately to *give them an incentive for maintaining the standards of accomplishment determined by his scientific experiments.*

It now should be recognized that here, coming into being, was an entirely new thing in management, the "central idea" of which, as Taylor came to describe it, was this:

(a) To give each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work.

(b) To pay extraordinarily high wages to those who perform their tasks in the allotted time, and ordinary wages to those who take more than their time allowance.[1]

But this brings us to the fact that standards of accomplishment for employees will be set in vain, and every possible incentive for maintaining those standards will be given them in vain, unless at the same time there is maintained that standardization of methods, equipment, materials, and general working conditions upon which standards of accomplishment depend. And of all the problems in standardization which confronted Taylor, this one of maintenance was by far the most nicely designed to exhaust his high courage and his superb power of will. If things and persons, once put, only would stay put! If only they did not have that well-nigh universal tendency to sag, lapse, deteriorate, and get out of tune! However, it is unlikely that there ever was a person freer than Taylor from the weakness of repining that things and persons are what they are. He cheerfully adapted himself and his work to the world as he found it, and this, not by any surrender of his ideals, but by resorting to every device necessary to bring his ideals to pass. And it was just in this way that there was brought into existence that complex of methods and mechanisms of management which became known as the Taylor System.

It signifies not merely that standardization inevitably leads to systemization, for the reason that without system standards cannot be maintained. It signifies also that *in proportion to the definiteness, determinateness, and high development of your standards must be the definiteness, determinateness, and high development of your system.*

[1] *On the Art of Cutting Metals*, pars. 2–3.

CHAPTER VII

LEADING FEATURES OF HIS SYSTEMIZATION

IN our previous chapter we were chiefly concerned with tracing the rationale of Taylor's course as he began the development of his system. And it is to be observed that if his course was logical from the beginning, it was because he was scientific by instinct — was *thoroughly sincere* in his desire for economy and in his search for the facts, and likewise in his willingness to follow the facts regardless of accepted beliefs or the effect on his personal fortunes. Could there, indeed, be a finer example of what H. G. Wells calls the scientific man's "intensity, integrity, breadth, boldness, patience, thoroughness, and faithfulness"?

Naturally it is not meant that Taylor's course was *straightforwardly* logical. Nothing in life moves that way. Things in life are very much mixed up, and even the movements which are prevailingly logical pass through many inconsequences, or what appear to be such. And while it is the art of the historian to simplify this complexity, as by so suppressing the inconsequences that the logic may appear, he yet must be on his guard against that undue simplification out of which comes the artificial, the essentially false. The complexity must at least be indicated.

Certainly Taylor's various problems in standardization were not presented to him in a chronological order nicely corresponding to their logical order of determination, establishment, and maintenance, but were all thrust upon him in varying degrees at practically the same time, so that he could not get one problem finally solved before proceeding to the next, but was compelled temporarily to resort to makeshifts with one while he dealt with others.

To begin with, he could not in his experimental "laboratory" determine finally what were the proper standards of accomplishment for his men. As these men attempted to perform the standard tasks set for them, they had to have their say, and sometimes their say revealed that wrong observations had been made in the "laboratory." It was in the actual practice of the shop that the standard finally was threshed out. The fact is that the detailed written instructions Taylor gave his men amounted to a time table for the doing of their work; and in telling a man he should take just so many minutes in which to do each of the things necessary to the completion of his job, the burden naturally rested on Taylor of proving that only those things were necessary and that his times were right.[1]

Of course, when a man protests that he cannot do a job in the time given him, it may prove that he has no earthly fitness for that job, or that, being fitted for it, he needs a lot of teaching to attain to the skill required. And this is what Taylor found repeatedly. A man, for example, might fail to come up to standard at milling-machine work because it was too complicated for him, whereas, placed at a drill press, he could make good. Still, even here he probably would have to be coached and encouraged; it might very well be that reaching standard to-day, he would begin to fall off tomorrow, seeing that his maintenance of the standard required the development in him of new *habits*.

But this was only one phase of Taylor's troubles in getting

[1] Taylor frequently referred to this as showing that with his methods it was not a case of management's imposing laws on employees. If in his philosophy the one best way as determined by due investigation and experiment became the law, the employees necessarily had a part in the investigation and experiment by which the law was determined. Neither the skilled worker chosen to operate the machine during the investigation nor the worker in the shop when the tryout was made was a "silent partner."

his standard tasks performed. One day a man might fail to perform his task because something went wrong with his machine. The next day he might be delayed by a slipping belt. Again he might have to wait for the instructions or the tools or the material he needed for a new job.

All in all, then, it will be seen how Taylor's most vexatious problem of maintaining standards was interwoven with his problems of determining and establishing standards.

As his experiments developed best ways, he immediately set about putting them into practice. The fact that Taylor was intent on the best does not mean that he could not make himself content with what was good enough *for the time being*. "To keep pressing after the best," says Barth, "is *sometimes* nothing short of a crime." With Taylor the main thing was to get output; and it is easy to see how this main problem at any particular time would have suffered if, in dealing with its various elements, he had waited to get each one perfected before proceeding to the next. All through his career it was characteristic of him to stop with a device which, however crude, represented a fair solution of the particular problem concerned and so permitted him to turn to something else which then and there also was in crying need of attention. Here, in fact, he exemplified that common sense which he defined as "the ability to decide as to the relative importance of things — the ability to select from among the several lines of action which lie before you, the one act which is best, the one act which will yield the largest return." It will be seen also that his method in building up his management system was nicely analogous to his methods of studying a machine, or that of "chasing down" and analyzing each defect, noting its effect upon the time problem, and centering upon the most important from that point of view.

Rough indeed were some of the devices he resorted to at Midvale for pushing work through. In other instances, however, he worked things out to a high degree, as in the case of his tool room, though here his system of nomenclature for tools was crude as compared with the classification and symbolization he developed later.

Among the " more important steps " attending the progress of his work that he listed in his metal-cutting paper, we find this: " In 1884, the design of an automatic grinder for grinding tools in lots, and the construction of a tool room for storing and issuing tools ready ground to the men." It was the building of the new machine shop that gave him the opportunity to take this radical action.

The thing had been foreshadowed by Sellers at his own plant. Sellers himself had designed an automatic grinder, and a fine one; and we are informed that " earlier than the year 1878 they had at the Sellers plant a " pretty well organized " tool room. But it was left to Taylor to develop the thing; his mechanism not only definitely fixing the responsibility for the maintenance of tools in standard condition, as was not done at the Sellers plant, but also accounting for and locating every tool, whether it had been issued to a workman, was being reground, or had been sent to the blacksmith for reforging. Incidentally it may be mentioned that the reason he was not content to adopt the Sellers grinder was that he wanted one which would work faster.[1]

His tool room again illustrates that the things he did were radical only in the sense that they represented a hastening to a conclusion of what was inevitably coming on.

Once the workman supplied practically all of his own tools. As machine-tools developed, these, along with the cutting tools used in them, had of course to be supplied by the

[1] Sellers, we believe, offered his men a bonus of a cent each for grinding tools to the standard shapes and angles adopted at his plant. However, as he had no system of inspection to insure this being done, it was done very imperfectly or not at all; and here is a concrete illustration of the dependence of standardization upon systemization.

management. Then as there developed finer and more costly hand-tools such as gages, these too were supplied by the management; and it became necessary to have a place in which to keep these hand-tools as well as the finer and more costly cutting tools such as drills and reamers. But such things as lathe tools and milling cutters continued to be left in the shop, supposedly at the machines where they would be needed; while blocks, bolts, and clamps were scattered about promiscuously. And the workman continued to supply such tools as monkey-wrenches, scribers, and calipers.

As management saw it must assume the responsibility for the shapes and angles of cutting tools, it was inevitable that it should arrange for the systematic care, storage, and issuance of all cutting tools; and this is what, to a degree, had happened at the Sellers' plant. Now came Taylor who saw that the management must predetermine the time for doing work, and this made it inevitable that the management should systematically provide, care for, store, and issue tools *of all descriptions.* If the workman had to go on spending time hunting for blocks, bolts, and clamps of the correct size and getting them into good condition, it would be impossible to determine for his work a standard time. Then, again, a standard time could be calculated only by determining the elementary times; and if, say, a proper time were to be allowed the workman for adjustments to his machine requiring the use of one or more wrenches, this could be done only on the basis of his having ready on his tool stand a wrench of the right kind and size.

So, though Taylor personally was careless about such things and often had to fine himself for violating his own system and leaving small implements around, it was inevitable that he should have hastened the establishment among tools of a beautiful order. Not only a place for everything and everything in its place, but also everything in proper variety, sufficient quantity, and the pink of condition. And withal a beautiful economy of storage space and facility of finding just what was wanted.[1]

Because of the amount of system made necessary to support it, standardization is likely to present an appearance of complication. It was Taylor's idea, however, that it really means simplification, and in illustration of this he wrote:

> It is far simpler to have all the tools in a standardized shop ground by one man to a few simple but rigidly maintained shapes than to have, as is usual in the old-style shop, each machinist spend a portion of each day at the grindstone, grinding his tools with radically wrong curves and cutting angles, merely because bad shapes are easier to grind than good.[2]

It came to be frequently protested that to take from workmen the power to select and care for their implements is to destroy their power of self-expression, their freedom as individuals. But perhaps the foregoing quotation will indicate that the only power of self-expression Taylor took from workmen was power to express their idiosyncrasy and caprice, and that if he curtailed any of their freedom, it was their freedom to follow the easiest way.

Another high development Taylor brought about at Midvale was his system of oiling machines. This device for maintaining things in standard condition created no end of amusement among Taylor's fellow officers, and the wonder of it still is talked about. All we can do here is to indicate its general nature.

To begin with, he had a man go over every machine and the moving parts connected with it and chalk every oil hole

[1] In like manner Taylor later devoloped a stores room of conditioned, inspected, and classified stores and worked materials, but the thing hardly was necessary at Midvale, where the materials mainly consisted of large forgings and castings. However, he at Midvale made progress toward the better standardization of materials.

[2] *On the Art of Cutting Metals*, p. 55.

and every surface that required oiling. Then he had another man cover the same ground to make sure that nothing had escaped the first. This done, he had a high-grade mechanic study the *best order* in which holes and surfaces should be oiled, and these places then were consecutively numbered by stamping.

For the oil holes he had made two sets of wooden plugs, one set with round heads and the other with square, and each set was numbered to correspond to the numbers of the oil holes. While one set was in the oil holes, the other set was kept in a box bored with holes to correspond to the oil holes. In like manner he had made for the surfaces to be oiled two sets of small hooks, one with round and the other with square tags.

In the morning, the operator of a machine found the oil holes fitted with square-headed plugs, and at the surfaces to be oiled hung the hooks with the square tags. Before starting his machine he was required to replace the "square" objects with the "round" ones, and as he did this to oil the hole or surface; and at noon, when another oiling was called for, he was required to replace the "round" plugs and hooks with the "square." The object, of course, was to make him give attention to each and every hole and surface, and do this in the proper order; and at any time it could be seen whether all his "square" or "round" plugs and hooks were in place as might be called for. Incidentally the plugs, which were cylindrical and made a neat fit in the holes, kept dust from getting in and cutting the bearings.

Taylor wrote that the "greatest obstacle in the application of this system was, as one would anticipate, the antipathy of the men to any innovation"; and he placed on one man the responsibility of keeping it running. Eventually to this man also was assigned the duty of oiling all the shafting and re-splicing or lacing all the belts.

Lists were made out of all the oil holes and surfaces to be oiled; these stating to what parts of the machines the holes conducted the oil, and the kind of oil to be used in each case. Duplicates of these lists were filed in the office; and here we can see an early development of the principle of reducing all recurrent procedure to standard practice and recording it. The ordinary way is to leave such procedure entirely to some individual, who in the course of time may work out for it a pretty good method. All of this knowledge, however, he carries in his head; so that if he falls ill, the procedure suffers, and if he quits the business, some one else must work it out all over again. Taylor not only required the management to determine *right at the start* the best method, but by his records he made the business independent of the comings and goings of individuals, and his records served as insurance against mistakes, failures of memory, and human fallibility in general.

He developed standard practice, not only for the machine shop, but also in connection with his position as master mechanic in charge of repairs and maintenance throughout the works. And in the case of the practice he worked out for the care of the boilers we have another example of wonderful thoroughness. There were detailed instructions to the engineer for cleaning the boilers out; instructions to a machinist for inspecting the boilers to see what parts required repairing while they were being cleaned; instructions to the fireman for letting the fires die out and for blowing the boilers off; instructions to a machinist for inspecting the boilers for such things as mud and scale and for taking out the grate bars; instructions for chipping scale, removing mud, and scraping soot and other deposits from the fire surfaces; and so on and so forth.

All such instructions were contained in a "standing order file," and a "tickler" system was developed for calling things

Duties of Clerk.

cleaning one week from that, Also notice to Assistant Engineer, dated 5days ahead of Supt's notice, that Boilers are due for cleaning two days from that time.

Make out the Clerks Report on cleaning of the Boilers, have it signed by the Chief Engineer, and then file it in the Permanent Record.

Standing Order showing duties of Clerk in Engineers Office when # Set of Boilers are to be cleaned

- - - - - - - - - - - - -

Five days before the cleaning of Boilers is to begin Inspect all of your standing orders and accompanying time-notes, and compare them with the full set kept in the Permanent Record of Boilers; to be sure that they are all on hand, and in order; and then place the full set of orders, properly sorted in a pile together in the order in which theyare wanted.

On the same day fill in Machinists name and date on standing order # 0 and give it to him: at the same time give him following note on which he must enter the repairs to be made, and return it to the Engineers Office on the same day.

- - - - - - - - - - - - - -

Machinists Report on repairs needed to # Boilers

Assistant Engineer.

The following repairs should be made while # set of boilers are blown out.

signed

Machinist.

- - - - - - - - - - - - -

4

MAKING STANDARD PRACTICE A MATTER OF RECORD

Page 4 of a 21-page document entitled "Duties of Clerk When Boilers are to be Cleaned"; showing that Taylor early adopted the practice of recording standard methods and of clearly defining responsibility. Midvale, about 1885

Method of Oiling Machines—Continued

thereby to save you a similar experience—

Two series of wooden plugs of various sizes. One lot having round heads and the other having square heads on them, are then fitted into each of the oil holes.

The part of these plugs which fit in the hole should not be tapered, as they are when they come from the makers, but should be cylindrical and a neat fit to the holes as they otherwise will fall out of place.

Small pieces of tin stamped with the same number as each of the oil holes are then screwed on to the top of the plugs so that we have one set of plugs with numbers corresponding to those stamped on the oil holes with round heads, and one set with square heads.

A wooden box is then made, in the bottom of which small holes are bored corresponding in size to the oil holes and stamped with the same numbers, each hole being made to fit its corresponding plug. Thus we are

MAKING STANDARD PRACTICE A MATTER OF RECORD
Page 3 of an 8-page document entitled "Method of Oiling Machines." Midvale, about 1885

up at the dates on which they needed to be done. It is said that Taylor got the tickler idea from what he had observed of the system used in banks for calling up notes due. Apparently he never went anywhere that his eyes were not open to see all that might be of use in his own business. Of course he did not stop with mechanism that called things up when they should be done, but must needs have a system of reports designed to show whether or not the things *had* been done.

As the building of the new machine shop, in 1884, facilitated the work of standardizing "small details," such as tools and the care of machines and belting, it gave him an enhanced opportunity to take advantage of the time-study and metal-cutting data that his "laboratory" up to that time had developed. In 1884, in fact, we can see his general system slowly getting under way; and, incidentally, this was the year he was more or less informally appointed chief engineer of the works by Superintendent Davenport. However, he had not yet made any progress with his main problem pertaining to the speeding of the machines. It was in this year that he employed Sinclair to work on this problem, and in 1887 Gantt. Headway with this problem began to be made in 1885; it was "from 1885 to 1889" that the work went on of "making a series of practical tables . . . by the aid of which it was possible to give definite tasks each day to the machinists who were running machines, and which resulted in a great increase in their output." [1]

These years, then, brought him close to the realization of what he came to call his "central idea," or that of giving "each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work." [2]

His principle of written instructions, except as seen in his working up of standard practice for such things as the care

[1] *On the Art of Cutting Metals*, par. 43.

[2] *Ibid.*, par. 2.

of boilers, was not highly developed at Midvale. In some cases he appears to have used a combination instruction and time card; the same card was used to tell the workman what to do and to require him to make a return in writing of what he had done. There was only a rudimentary mechanism for recording and analyzing the progress of work; the following up mostly was done by a " chaser " or walking time-keeper who went around to check off what the men did. In short, there was here scarcely any refinement or elaboration of mechanism; and as a matter of fact, there was little necessity for it, since the shop was small (apparently in Taylor's day it never contained more than thirty machines) and the work done (mainly that of machining locomotive tires and car axles) was largely confined to a few operations of a simple and repetitive nature in which the machining time was much greater than the handling time. Also because of this lack of complexity, there was little need of the smooth coördination of mechanisms that Taylor later effected in his highly-organized planning room. At Midvale this coördination mainly was done in Taylor's own head.

Mention surely must be made of the fact that at Midvale was hung up the first specimen of what was destined to become Taylor's famous shop bulletin-board, this having hooks on which to affix tags or slips showing the work ahead for each machine. That this board had to be protected by a glass case to keep men from tearing off the tags, bespeaks the opposition Taylor encountered on every hand because of that well known " antipathy to innovation." And the fact was that the object it served of keeping work flowing was strictly in the interests of the piece workers in the measure that it prevented them from losing time by having to wait for a new job upon the completion of an old.[1]

[1] It illustrates what is brought by the whirligig of time that several years after Taylor's death the head of a labor union remarked at a private dis-

Thus far we have seen that, with Taylor's deliberation inevitably leading to experimentation, and this latter work leading in its turn to standardization, his problem of maintaining standards was essentially a problem in system building. But here now is the fact that no system of management is self-operating, that to operate any such system you must have an organized body of persons. This being so, it will be seen that Taylor's problem of maintaining standards was not merely a problem in system building, but was also and at the same time a problem in organization building.

---

cussion that his opposition to piece work in his particular industry (one notorious for its labor troubles) was partly due to the fact that it would be impossible to figure out how piece workers should be compensated for the time during which they stood around waiting for new jobs as long as the employers were not enlightened enough to utilize the Taylor mechanism that reduced such waiting to the minimum.

CHAPTER VIII

ORGANIZATION PREVIOUS TO TAYLOR

THE fact is, of course, that system and organization are each necessary for the working of the other.

An organization, in the sense we here are considering it, has been well defined as "a collection of persons working together for a common end." But before you can collect persons and get them to work together, you must have some plan or scheme, with appropriate mechanism, for directing or managing their efforts.

This will clearly appear when we consider that organization as an act or art can be defined as "the division of the work to be done into defined tasks, and the assignment of those tasks to individuals qualified by training and natural characteristics for their efficient accomplishment."

While it may be proper to speak of "the division of the work to be done into defined tasks" as organizing the work, this is because organize and systemize sometimes are interchangeable terms. It is certain that as you divide the work in this way, you are not building up an organization, but the system which is the prerequisite to an organization.

It is when you come to assign your "defined tasks to individuals qualified by training and natural characteristics for their efficient accomplishment" that you proceed from system-building to organization-building.

It may be said that Taylor's system-building began as he resorted to the method of issuing to his men the detailed instructions in writing which constituted their well-defined tasks. No sooner had he done this than he was confronted by the necessity of assigning the tasks to men who were qualified for them. Thus organization-building had to attend his system-building from the very outset.

Not only this, but involved in his system was organization-building *of the most intensive kind.* Your defined tasks, as we have seen, should be assigned to persons qualified for them, not only by natural characteristics, but also by *training.*

Here the attitude of the ordinary manager is likely to be that of looking for people *someone else* has trained. But as the tasks set by Taylor were so clearly defined and thus raised such high standards of accomplishment, he simply *had* to train his own. And this training, this patient teaching and development of employees, he came to regard of such importance that he established it as one of the four most fundamental principles of Scientific Management.

Just as Taylor's method of setting tasks for his men was only the beginning of his system-building, so, of course, the selection and training of workmen that this made necessary was only the beginning of his organization-building.

And this brings us to a factor in the art of organization which, though implied in the definition given, was not there specifically stated; this factor or principle being that all the defined tasks into which you divide work must be within the capacity of individual attainment, and more especially within the capacities of the individuals available for appointment to your tasks.

We may be sure that Taylor set no tasks for his men that were not well within their individual capacities as they were naturally fitted for and were trained in the tasks. *But what about the task he, the foreman or manager, set for himself when he assumed the duty of setting those tasks for his men?*

It was not only that this involved the responsibility of selecting and training the men, and of seeing that a new job with the proper instructions was ready for each man as soon as he finished the one upon which he was working, and of seeing that the men understood their instructions and started in right, and of seeing that no man was prevented from doing his work in the allotted time by any default in the condition or supply of his equipment and materials. In addition to all this, there rested upon Taylor the burden of looking out for the quality of the work done by the men, of keeping their time, and of maintaining discipline among them.

Now, the fact is that in all this there was scarcely a thing which every foreman was not supposed to do to *some* extent. Every foreman was supposed to see that the piece-rates were accurate and just, to see that all the men were suited to their jobs, to assign work to the men and keep track of the work through the shop, to give the men more or less instruction, to see that all the machinery was kept in good condition, to see that all the men were kept busy, and so on and so forth. This signifies that in these years — the early 1880's — the position of foreman, at least in every sizable machine shop, already had become an impossible one in the sense that in connection with it there had developed a great many more duties than could be *thoroughly* discharged by any man not a superman.

We shall the better understand how this came about, if we consider something of how industrial organization itself came about; and as we do this, albeit in a very sketchy way, it incidentally should help to make plain that in all particulars Taylor's work represented but an intensification and acceleration of that progressive movement by which man throughout the ages has steadily increased his power over nature.

The emphasis frequently placed on manual or muscular work in production is a false one. From the beginning our wealth mainly has come from the application to nature of intellect. And the triumphs of the intellect in production have all along taken two forms: first, the development of tools and skill in handling; second, the development of organization and skill in directing.

We may say that the development of tools began when man abandoned stone implements for metal. We may say that industrial organization began when it was discovered that two or more men working together by dividing the work could produce more than the total they produced when each worked by himself; the explanation of this phenomenon lying in the fact that, as work is divided, it permits the individual to stick to some one part of it and thus not only save the time spent in passing from one part to another, but also, through specialization in this one part, to develop a skill or expertness which otherwise would be impossible for him.

The first industrial organization was what we now call the social organization; it pertained to society's activities as a whole and, Topsy-like, grew up "just naturally." And until modern industry began, the division of work scarcely proceeded further than was represented by the self-directed specialization of individuals in the making of particular products such as clothing and shoes, or in the performance of particular classes of work such as goldsmithing and blacksmithing.

What gave rise to modern industry was the development of those tools we now call labor-saving machinery. Previously the individual had, as the saying is, worked for himself. Now, to take advantage of the labor-saving machinery, workers became aggregated in factories; and as this occurred, work had to be *deliberately* organized; that is, in accordance with a thought-out or predetermined plan or system.

Thus the specialization in the making of particular products which previously had been undertaken by individuals was now undertaken by organizations within the social organization, and so there came about a subdivision of work that practically amounted to a division in accordance with a new principle: work now began to be divided in accordance with *the particular functions, processes, operations, or steps involved in its performance,* whatever might be the nature of the goods produced.

Take, for example, the manufacture of pins, one of the earliest cases of quantity production effected by labor-saving machinery. Babbage's *Economy of Machinery and Manufacture* shows that this particular manufacture, as early practiced, involved these things: (1) drawing wire; (2) straightening wire; (3) pointing; (4) twisting and cutting the heads; (5) heading; (6) tinning or whitening; (7) papering.

This means that deliberation upon the work of manufacturing pins proved that it was made up of seven processes or steps which, though interconnected, were not only readily distinguishable by the mind, but also readily separable in practice. Deliberation also proved that the performance of these various processes called for various degrees of mental and physical ability. For example, drawing the wire called for a man's strength, while straightening the wire could be done by a woman or a girl. Clearly, then, it was of advantage to split the work up into these various processes; for, as Babbage pointed out,

> . . . the master manufacturer, by dividing the work into different processes, each requiring different degrees of skill and force, can purchase exactly that precise quantity of both which is necessary for each process; whereas, if the whole work were executed by one workman, that person must possess sufficient skill to perform the most difficult and sufficient strength to execute the most laborious of the operations into which the work is divided.

Here appears the economic principle, practiced by none more consistently than Taylor, that none of the time of higher-priced labor should be devoted to work that can be done by lower-priced labor. Then, again, as you deliberate upon the organization of work, it must be revealed that the more you divide the work into its elementary processes or steps, the more simple will be the tasks you set for performance by individuals, and the easier it thus will be for you to find individuals who can attain expertness in your tasks through specialization.

But now let us examine Babbage's phrase, "the master manufacturer." This harks back to the days when, for the most part, factories were personally conducted by their owners, who usually were workmen of superior intelligence, industry, thrift, and enterprise. In most cases also, while factories remained small and their machinery primitive, the owner continued to ply his trade at the same time that he directed the general work, just as we see to-day in barber-shops where there is a boss-barber employing assistants.

However, as machinery developed and the factory became larger, the master-workman had to give all his time to directing the general work, so that he ceased to be a workman and became a master or boss pure and simple. And here occurred what really was the primary division of work according to the principle of function, process, operation, or step: *the function of directing or managing the work became segregated from the function of executing it.*

Now, the function of managing can be analyzed into two principal sub-functions: that of planning the work, and that of seeing to its execution, or of leading, guiding, instructing, and inspiring the executors or manual workers. And in the distinction between these two sub-functions, which has become clearer and clearer, we have the ultra-modern distinction between management engineer and the executive.

From the beginning, the master or boss — that is, the manager — had to plan the work in the sense that he had deliberately to organize or systemize it. For some time, however, his planning problem was simple; the factory being small, and the tools, both hand and machine, being simple.

It was as machinery developed that the manager's planning problem became ever more complex.

The development of machinery meant the production of goods in larger and larger quantities, and it proved, as things worked out on the whole, that these larger quantities only had to be produced to be absorbed. Hence the factory increased in size — workers became aggregated in them in larger and larger units — and this increase of size by itself gave impetus to the division of work into its elementary processes.

In addition to this, the development of machinery was along two principal lines; the first represented by the designing of machines for dealing with more and more of the processes into which work can be split up, and the second represented by the designing of machines to work with greater and greater degrees of automaticity. Thus machinery as a whole became more and more complex — that is, made up of more and more kinds of machines — and at the same time the individual machine became more and more complex, or made up of more and more parts. This in turn made the work of operating machinery more and more complex, and so compelled greater and greater degrees of specialization among machine operatives.

Naturally, the more complex work becomes — the more it is made up of segregated but interdependent parts or processes — the more complex becomes the problem of managing it. In its broadest terms the problem is to have each part well performed as a distinct entity, and at the same time so organize all the parts as to compel each to act as an efficient part of the whole, a problem analogous to the problem of mechanical design, or "the science of dividing the conception of a machine to perform a main purpose into definite parts, each of which performs a lesser function in the furtherance of this main purpose."

All along the increasing complexity of management had been met by dividing the work up into more and more departments and sub-departments generally corresponding to processes or operations, placing a subordinate manager in charge of each of these divisions, and clothing him with plenitudinary authority over the workers in his division. And so grew up what Taylor came to call the military type of organization.

In the lectures that, beginning in 1909, he gave at Harvard's Graduate School of Business Administration, he dealt thoroughly with this type of organization; choosing for his illustration an engineering establishment "producing a somewhat miscellaneous lot of machinery, for the reason that this type of manufacture calls for, in most respects, the most elaborate kind of organization." After referring to such departments as engineering (or department of design), purchasing, manufacturing, and sales, he continued:

To illustrate further this military type of organization; the superintendent in charge of the manufacture of the machines would ordinarily divide the manufacturing department into a number of sub-departments, such as the machine shop, blacksmith shop, pattern shop, foundry, erecting shop, etc., and at the head of each of these departments would be placed either a superintendent or foreman according to the size of the establishment. Again, the superintendent at the head of each of these departments, as, for instance, the head of the machine shop, would place a number of foremen or gang bosses in charge of different sections of the shop. In a properly-designed and well-built machine shop, all the machines of a certain type and size would be located in a group together; as, for instance, all large planers in one group, small in another; milling machines in one section of the shop, and drill presses in another; and so forth, and a foreman or gang boss would be placed in command of each of these groups of machines. If each of these groups contains a large number of machines, it would then be desirable to have one or more sub-foremen or gang bosses placed in charge of sections of the groups;

and finally, each of these gang bosses would be in personal command of the small group of workmen directly under him. Each of these workmen would receive all of his orders and all of his directions and instructions from the one gang boss over him.

And, as you know, one of the cardinal principles of the military type of management is that every man in the organization shall receive his orders directly through the one superior officer who is over him. If the general superintendent of the works wants to give an order to a particular workman, instead of going directly to the workman and telling him what to do, he transmits his order in proper form through the various officers under him to the workman, in the same way that orders through a general in command of a division are transmitted through colonels, majors, captains, lieutenants and non-commissioned officers, to the men.

Years of experience with this type of management have emphasized the necessity for the orderly transmission of directions from the superior officer to his immediate subordinates, etc., so that it has become a cardinal principle, in fact a proverb, that "no man can serve two masters." The military type of management has become so familiar to us in our every-day lives that it is difficult for us at first to realize the possibility even of the existence of any other type.[1]

In his paper of 1903, *Shop Management*, Taylor referred to the grouping of machine-tools according to kind and the placing of an assistant foreman or gang boss in charge of each group, as an attempt to make foremanship "more effective" by demanding "a smaller range of experience and less diversity of knowledge" from foremen in general. The gang boss, however, was "called upon to perform duties of almost as great variety as those of the foreman himself," and this was because, like the foreman himself, he was clothed, under the "military" type of organization, with plenitudinary authority over the workers in his division, or, as Taylor expressed it, he was expected to "command the men under him in all things."

[1] Quoted from manuscript Taylor prepared as a basis for his lectures.

It is true that in *Shop Management* and in his Harvard lectures Taylor spoke from the point of view of the 1900's, and that in the early 1880's, when he began his own foreman's career, there was not such a high development of machinery and the foreman's job in consequence was not quite so complicated. Nevertheless, the difference in degree was not very great; then, as later, the ordinary foreman could make only a feeble or superficial attempt to discharge all the duties he was so supposed to discharge.[1]

As a matter of fact, the theory on which the foreman worked was that the men under him knew their trade, and it could be left almost entirely to them to select their implements and methods. What Taylor called the "final problem" of doing the work was put up to the workman. Some assistance the workman might get from the foreman, but not much. Usually the only work the foreman attempted to supervise with any care was new, especially difficult, or very important work. In general, the workman was left to his own devices; and if he did not come up to the foreman's *personal* standard, he usually was quickly fired; little attempt being made to teach or train him.

But Fred Taylor was not content to be an ordinary foreman. Every duty, every responsibility, every function he was supposed to discharge, he would discharge, and that *thoroughly*. And this brings us back to the question as to the task he assumed. He was not an ordinary person. He was quite extraordinary. But could even such a person as he measure up to such a job? The answer is that, if only because of the limitation put upon the individual by time, he could not; and it was as he was made to realize this that he unconsciously began to develop a new type of organization.

[1] In *Shop Management* (p. 96) Taylor lists the duties supposed to be discharged by a gang boss under the ordinary type of management, with the object of showing that they call for qualities which, if they ever were all found in any one man, would entitle him to be made the superintendent of the works.

CHAPTER IX

TAYLOR'S FUNCTIONAL ORGANIZATION

FOR one who was a glutton for responsibility, and had, by his habit of getting practical results, demonstrated to his employer that they could leave him to follow his own head, what Taylor did as he found that he could not thoroughly discharge all of his foreman's duties was the most natural thing in the world: he employed assistants. And it was as he pursued this course that he developed a new type of organization.

The beginning of this appears when he employed a man to make time studies. Eventually to this man was assigned the duty of writing out the instruction cards on which, in accordance with the data accumulated by the time studies, the workmen were told in detail what to do and the time they should take. But here is the fact that, to assign daily to each workman a carefully-measured task, you must lay out the work in advance. As Taylor could not definitely plan ahead unless he had before him data showing just what work had been done, he, among other things, got the workmen each day to make returns in writing. And so he selected a man to help him plan ahead, at least to the extent of making out the tickets on which the workmen recorded what they had done, and seeing that no man neglected doing this and doing it properly.

From our present vantage-ground it is plain that what he did as he employed these assistants was to detach from his work as foreman certain specific duties or functions and assign them to men who were free to specialize in them; which is to say that he acted on the principle of segregating the work of the foreman or manager by function.

At Midvale he split up his manager's work still further, and later on, when he had become what is called nowadays a consulting engineer in management, he was led further and further to divide and sub-divide the work of management; and so grew up what is now termed the functional type of organization to distinguish it from the military type.

We call the functional type new. We have seen, however, that as work began to be deliberately organized, it began to be divided in accordance with the particular functions, processes or operations involved in its performance. Hence the organization of work from the beginning was in the nature of segregation by function; and this being so, it follows that Taylor's course in developing his new type represented but a forward step in the natural evolution of industrial organization, and it is permissible to call it new only in the sense that a difference in degree can amount to a difference in kind.

All progressive evolution, whether industrial or biological, is indeed nothing more than an advance in organization from simpler to more complex forms. "Biological progress," says Professor Conklin of Princeton, "means increasing complexity of structure and functions, increasing specialization, and co-operation of the parts and activities of organisms, and human progress, whether physical, intellectual or social, means no more and no less than this."

What Taylor did first of all, by reason of his thoroughness and force in defining tasks and setting high standards of accomplishment, was to make the segregation of work by function far sharper.

It has been said that the primary division of work in accordance with function was the segregation of the function of managing it from the function of executing it. The fact is, however, that in the 1880's even this primary segregation remained incomplete and indistinct, as will be recognized when we recall that the function of managing work involves the two sub-functions of planning it and of seeing to its execution, but that in the 1880's a great deal of the planning still was left to the executors or manual workers. As a matter of fact, the typical manager of that period put all the emphasis on his executive function; he was very little of a planner, very little of an engineer.[1]

The general failure up to this time sharply to define and segregate functions signifies that the deliberate organization of work had not gone far. *On its own function and the sub-functions involved in it,* management hardly had begun to deliberate at all. It had not yet attained the self-consciousness which is the prerequisite to self-analysis.

In 1912, after the railroad-rate hearings had created wide interest in this general subject, A. Hamilton Church, a consulting engineer, said:

> Scientific men tell us that the great difference between a savage race and a highly civilized one is that the former remains in a condition of natural innocence, and the latter has arrived at self-consciousness. This, I think, is the real state of affairs in regard to engineering. We are passing from a stage in which there was a

[1] The proposition that the work of planning *naturally* belongs to management rests not only on the fact that the planning should be based on due investigation conducted with the expertness that comes from specialization, but also, and perhaps mainly, on the fact that economy dictates that the planning should be done in advance. Obviously the manager, as the first step in any enterprise, must plan in advance if only to the extent of determining what work is to be done and of preparing for its execution by providing a suitable workplace with its equipment. If he waited to do this until the executors were collected, there would be delay in their getting to work and a loss of their time. And this axiom holds good throughout: *in proportion to the extent which work is planned before its execution is attempted will time be saved in its execution.* A large part of the results Taylor obtained as an economist was due to his extension of pre-planning to the small details of the shop, thus avoiding those "incidental delays" which occur when workers are left to chase up their tools and materials and see that they are in proper condition, and especially when workers are left to form little debating societies to decide upon their methods. Really it all comes down to the homely old adage: first plan your work, then work your plan.

simple and unconscious following of tradition, into a stage of self-consciousness in which we are moved to subject our habits and our motives to severe self-scrutiny, and examine afresh every item of our daily practice. It is a very painful stage to have arrived at. Most of us are so content with our comfortable natural innocence that we do not like to part with it, but it is the process that, once commenced, must continue.[1]

That the events which led to this awakening were shaping in the 1880's, we cannot doubt. If the typical manager of this period was very little of a planner or engineer, the fact is that as long as machinery remained comparatively simple, he did not have to be. With the increasing complexity of machinery that began in the 1880's came an increasing complexity of knowledge pertaining to its operation as well as to its designing; knowledge has only to attain a certain degree of complexity to compel its reduction to a science; the rank and file of employees, though they may and to a large extent needs must participate in the reduction of their work to a science, cannot direct it; this task must be undertaken by the single force we call the management; and as management does undertake this task, it must become aroused to all its duties, responsibilities, and functions.

Looking at it from this angle, we see that Taylor assumes the aspect simply of a manager of such thoroughness and force that he leaped from a quarter to a half century ahead of the crowd of managers, and did more than any other one individual to wake management up and blaze a trail for it to follow.

It is plain that his work in sharply defining and segregating functions began when, that he might be able to establish scientific standards of accomplishment for his men, he relieved them of all the work of planning and concentrated it in him-

[1] From Mr. Church's discussion at the A.S.M.E. of the committee report on "The Present State of the Art of Industrial Management."

self, the manager. Thereby he committed himself to the principle that planning is one function and execution distinctly another one, and here was a division of duty as sweeping as it was definite. And it was mainly because of his concentration of all the planning in management that he was compelled to divide and sub-divide its work.

Taylor called the first two men whom he employed to help him with his foreman's work the instruction-card clerk and the time clerk. Being clerical workers, these men had to have desks, and naturally these desks were placed in juxtaposition with the time-study records that were accumulating. So here, visible to the naked eye, was the crude beginning of a department destined to become the most conspicuous feature of the Taylor System; namely, the planning department.

> Planning [says J. E. Otterson] is a function of an engineering order, and execution is a function of an executive order. In military organization this distinction is recognized in the staff and line. . . . Staff work and engineering work grow in importance with the complexity of the problem. As the problem becomes more and more complex it becomes more and more difficult for those concerned with the development of the plan to devote their time and energies to its execution; and, in turn, for those concerned with its execution to devote their time and energies to the formulation or development of the plan.
>
> A study of any phase of the operations of the late war [during which the machinery of warfare attained a complexity previously undreamed of] will show the increased importance in modern warfare of the staff or planning department, and the disposition to separate execution or production from planning.[1]

Because of the close analogy between the planning department of Taylor's industrial organization and the staff work of military organization, it has been suggested that Taylor was

[1] Paper printed in *The Annals* of the American Academy of Political and Social Science, September, 1919.

not quite fortunate in designating the old type of industrial organization the "military" type to distinguish it from his functional type. That, however, he had in mind a distinction carrying with it a great difference, will be evident from what happened at Midvale when his instruction-card clerk became expert in his special duty.

As the instructions on these cards were based on the scientific data that had been developed concerning the men's work, there was no reason why they should not be sent to the men directly and they were so sent. Plainly these cards served as the workmen's orders. *But these orders did not go to the workmen either from or through Taylor, their foreman, and neither did they reach the workmen through the assistant foreman who was called the gang boss.* Thus here was a violation of the old principle, whether you call it military or not — perhaps it would be better to call it bureaucratic — that no man shall receive an order except from or through his immediate superior.

Again this principle was violated in the case of the time clerk whose special duty it was to see that the workmen made proper returns of what they did each day, and it was even more clearly violated when Taylor trained a man for the special duty of inspecting the work; it being this inspector's duty not merely to determine whether the work as finally done was up to standard, but first of all to explain to the men the engineering drawings and the exact quality of the work required — the kind of finish and degree of accuracy — and then to see that the men got started right by inspecting their first pieces. And as Taylor continued to develop his functional organization, especially after leaving Midvale, where he hardly grasped its import, the workmen became subject to more and more "bosses."

What, then, it may be asked, did Taylor do to the good old proverb that no man can serve two masters? The answer is that though, to all appearances, men under the functional type of organization are required to serve, not merely two, but three or four or more masters, it is in the appearance only. Actually they serve but one; and as we are able to grasp this, we shall be able to comprehend Taylor's work in its higher significance and understand the man as few understood him during his lifetime.

We quote from the manuscript he prepared for his Harvard lectures, the italics being his:

> You realize, of course, that the military type of management has been here entirely abandoned, and that each one of these functional foremen is king over his particular function; that is, *king over the particular class of acts which he understands, and which he directs;* and that not only all of the workmen throughout the place obey the orders of this functional foreman in his limited sphere, *but that every other functional foreman obeys his orders in this one respect.*
>
> Thus we have a radically new, and what at first appears exceedingly confusing state of things, in which every man, foreman as well as workman, receives and obeys orders from many other men, and in the case of the various functional foremen they continually give orders in their own particular line to the very men from whom they are receiving orders in other lines. For this reason the work of the Planning Department represents an intricate mass of interwoven orders or directions, proceeding backward and forward between the men in charge of the various functions of management.

By the term king, Taylor meant to signify a man whose orders *must* be obeyed. But whereas the "military" king's orders must be obeyed in every particular, plenitudinary power being vested in him by virtue of the *position* he holds, the functional king's orders must be obeyed only in a certain limited particular, and this by virtue of the *knowledge* he holds. That is to say, the functional boss gives orders only as, through specialization, he is expert in some particular form or part of knowledge, and by the same token, he must take orders from those who are expert in other forms or parts of knowledge. And so the seeming confusion is resolved: actually there is only one master, one boss; namely, knowledge. This, at all events, was the state of things Taylor strove to bring about in industry. He there spent his strength trying to enthrone knowledge as king.

And this explains the emphasis he put upon "intimate, friendly coöperation." Knowledge can rule in an organization only as its members work together democratically. Each member must play into the hands of all the other members. To do this, he must appreciate the parts played by others, and see his own in its true relation to theirs. But it is not enough that he have this appreciation of parts in the abstract. He must have a friendly feeling for the persons who play those other parts.

The idea of coöperation, with all the democracy that involves, entered into the warp and woof of Taylor's whole philosophy of life. When, in 1907, the *Engineering News* published a tribute to his work in revolutionizing the art of cutting metals, he, in protesting to the editor that too much credit had been given him personally, wrote: "I feel strongly that work of any account, in order to be done rightly, should be done through true coöperation, rather than through the individual effort of any one man; and, in fact, I should feel rather ashamed of any achievement in which I attempted to do the whole thing myself."

That all the particular tasks which contribute to the accomplishment of a general task are equally worthy of respect; that one man is indeed as good as another *as he plays his part as well as the other man plays his;* that as the other fellow plays his part he is serving you as well as himself and therefore stands to you in the relation, not of non-ego, but of alter ego — this with Taylor was not simply a matter of intellectual conviction, but of deep, subjective, emotional belief.

It is significant that he had comparatively little difficulty in "selling" his principles and methods to working people. His own estimate was that nine-tenths of his troubles were with men in the management. As he extended his functional principle to management, it acted on the typical foreman or manager of his day "as the proverbial red rag on the bull."[1] Doubtless in many cases the foreman honestly feared that his usefulness was being contracted.

> This is, however [said Taylor], a theoretical difficulty, which disappears when they [the functional foremen] really get into the full swing of their new positions. In fact, the new position demands an amount of special information, forethought, and a clear-cut, definite responsibility that they have never even approximated in the past, and which is amply sufficient to keep all of their best faculties and energies alive and fully occupied.[2]

Again he said:

> I am quite sure that many of you will question whether the functional foreman and the men who together constitute the planning room are not narrowed by the small range of their duties. I can assure you, however, that directly the opposite is true. While their duties are confined to a very much smaller field, still in their particular field much, *very much,* is demanded of the men, and it is our experience that when a man once becomes *thorough* in his knowledge and in the practice of this knowledge he becomes eager and ambitious for more knowledge of this thorough kind.[3]

He also pointed out that men who are fitted for it can learn more than one function and so become eligible for positions as general managers or superintendents, and that a man becomes "truly broad in the measure that he gets into real touch with the vital, underlying facts and laws of the universe."

[1] *Shop Management*, p. 107.
[2] *Ibid.*, p. 145.
[3] Harvard lectures.

For the light it will throw on the intensely human dramas that were played wherever Taylor appeared as a consulting engineer, it is important that we have a just conception of the effect of his functional principle upon management positions of the higher or general type, and to obtain such a conception it is necessary that we understand something of the functional principle's psychological basis.

CHAPTER X

THE FUNCTIONAL PRINCIPLE AND THE GENERAL MANAGER

BY some of his acquaintances, Taylor was considered to be as weak in such sciences as those of psychology and physiology as he was strong in such sciences as those of engineering and chemistry. Undoubtedly he was at his best when he had tangible things to cope with.

As its laws bear on economy of production or conservation of human or material energy, every science must play a part in a science of management; and when we consider organization, we find that the part played by psychology is a leading one, since the division of work should not be arbitrary, but be in accordance with the natural capabilities of men.

However weak may have been Taylor's grasp of the laws of this science even in his later years, when such a science really had begun to be developed, it yet would appear that his organization building at all times was deeply psychological, by reason of his practical experience with men, his intuition, and of what he learned from "trial and error."

As he got his instruction cards working at Midvale, he and his gang boss ceased to originate the orders that went to the workmen. This means that their duty as foremen became largely restricted to seeing that the orders were carried out. Here, then, began to be established a sharp division of the work of management according to its principal sub-divisions of planning and execution; and it already had been noted that men can be divided into two correspondingly broad types; namely, the engineering and the executive.

We find [indeed] these two types in all professions and human activities and at all stages and levels thereof. . . .

For example, we have lawyers of the legal engineering type whose success rests upon their technical knowledge of the law and who approach a legal problem very much as an engineer approaches an engineering problem. In the same way we have lawyers of the executive type, whose success rests upon their ability to handle a case in court with the material furnished them by the legal engineer. . . .

In the medical profession we find the same condition to exist. We find medical engineers engaged in scientific study, research and diagnosis, and medical executives engaged in the application of medical and surgical laws to a vast number of current cases, or medical executives engaged in the management of sanitariums and hospitals.[1]

If, in basing his industrial organization on a sharp division of duty along the two general lines of planning and execution, Taylor wrought in accord with natural law, this should encourage us to believe that as he split up both the planning and executive functions into sub-functions, he continued to work along psychological lines, in that his sub-functions fell into groups, each of which required for its performance a distinct type of mind or form of capability naturally existing.

The analysis by which he determined the functions of management and their scope and interrelations was with him a labor of years; it being subject to correction and extension.

As he split up the old-time foreman's planning function into various sub-functions, the men assigned to these functions became generally known as clerks, this arising naturally from the fact that their duties generally were clerical.[2] And be-

[1] J. E. Otterson.

[2] As Taylor developed his system, the leading men in his planning department became in many cases high-priced specialists. Despite this, he continued to refer to them generally as clerks, evidently from old force of habit in calling things by their commonest names, especially the terms current in the shop during the days of his first-hand contact with industry. He had, moreover, a deep seated aversion to all high-sounding titles. In these latter days, however, the term clerk has generally been dropped in connection with the higher planning officials.

cause the planning function is generally clerical, requiring for its discharge desks, files, etc., and because also of the close interrelation of its sub-functions, the distinct entity known as the planning department represented not only the segregation of the planning function but also its localization.

In a work of this kind we of course cannot undertake anything resembling a thorough exposition of Taylor's planning department. Suffice it here to say, that under his direction it eventually came to include seven distinct types of clerks: production, route, balance of stores, instruction card and time study, order of work, recording, and cost accounting; the limiting title in each case signifying a particular planning function, or some duty auxiliary to it.

As, on the other hand, the old-time foreman's executive function was split up, the men who discharged these sub-functions retained the general title of boss; and of these there came to be four types respectively known as repair, gang, speed, and inspector. Shop-floor agents of the planning men, Taylor called these executive men.

Other functions he defined were of a general type, or auxiliary to both the planning and the executive functions, as in the case of his shop disciplinarian, who was placed in charge of all the "hiring and firing" and was the forerunner of the modern employment or personnel manager.

Of course Taylor did not define functions with the idea that there necessarily must be a man for each function. He recognized that, as businesses vary in nature or in size, one man may perform two or more functions, or one function may be performed by two or more men. Here, in fact, arises the distinction between system and organization. The *definition* of functions pertains to the laying out of a system; the *assignment* of functions to the building of an organization to work the system.

Taylor defined the functions of management as he reflected on the particular things it was necessary for it to do so as to discharge its general task with the maximum economy.[1] In practice he assigned these functions with a view to giving no man more work than he could handle thoroughly and expeditiously. At the same time it is to be recognized that in practice system and organization are inseparable; and it follows from this that, while economic considerations primarily must govern the definition of functions, psychological considerations also must enter into it immediately; which is to say that as it is the mission of functions to be performed, they must be defined with a view to their performance. Certainly the organization must fit the system, and the system the organization.

Since Taylor's death progress has been made in the analysis of functions as in other features of his work. This very progress, however, serves to indicate that, in defining the subfunctions of the planning and executive functions, he continued to work along psychological lines.

Nowadays it is generally held by close students of Taylor's work that every task naturally breaks down into the five principal functions of planning, preparation, scheduling, production, and inspection; each of these representing a distinct step in the progress of work from purpose to accomplishment, and each requiring for its performance a distinct type of mind.

In this narrower sense, planning is the determination of *what* is to be done and *how;* preparation refers to the provision of the equipment and all other facilities for the performance of the task (manifestly a distinct part of the *how*); scheduling

[1] One of the most interesting attempts at an exact and systematic statement of the economic laws governing the definition of functions is that made by Lieutenant G. J. Meyers in an article originally printed in the *Journal of the American Society of Naval Engineers*, and reprinted in *Scientific Management* (*A Collection of the More Significant Articles Describing the Taylor System of Management*), edited by C. B. Thompson, and published (1914) by the Harvard University Press. Lieutenant Meyers' article well illustrates that, in defining functions, Taylor did not invent them; that he simply segregated things which all along had been done by some one in some manner.

is the determination of *when* the task is to be performed or when each of the things that enter into it is to be started; production is the actual doing of the work in accordance with the plan, through the application of force or energy; inspection is the determination of the satisfactoriness of the accomplishment in the light of the standard planned, and involves all devices for the checking up or judging of results.

Planning, preparation, and scheduling, as thus defined, pertain to the general planning or engineering function; production and inspection to the executive function.

In the Taylor System, as applied, for example, to the shop of a machine-building establishment, the determination of *what* is to be made (that is, the specifications defining the physical object) is the function of the (mechanical) engineering room, which prepares drawings for the product and sometimes incidentally for any special machinery or tools that may be needed, and thus is really a section of the general planning department.

The engineering room having determined this, it is the general function of the planning room to plan the production and to determine the preparation and the scheduling.

The route man is concerned with the determination of the major plans relating to the provision and use of machines, tools, special equipment, and materials for doing each part of the work or operation concerned in it. The instruction card and time-study man is concerned with the determination of the detail methods to be followed in operating the machinery and handling the tools and materials.

On the other hand, the production man and the order-of-work man are concerned with the scheduling; the production man determining all the large matters in this connection, and the order-of-work man the details.[1]

[1] For a detailed statement of the duties of these functional men see H. K. Hathaway's article on *The Planning Department*, reprinted in C. B. Thompson's *Scientific Management*.

Turning now to the floor of the shop, we find that Taylor's gang boss and speed boss are both productionists, or men concerned with the actual carrying out of the plans; and there also is the inspector, who, if he incidentally acts as the shop-floor agent of the engineering room in interpreting the drawings to the executors or workmen, has for his main function the checking up of the accomplishment.

Planning requires a studious mind with both analytical and synthetical power, or power of constructive imagination. Preparation requires a mind of the ingenious, inventive, resourceful type. Scheduling, essentially the making of a time table for dispatching, calls for a mind of the distinctly clerical type; orderly, with a fine sense of sequence, and fond of routine. The productionist should be aggressive, driving, persistent; able to control men, to direct, guide, and lead them. The inspector must have an investigating mind; patient, exact, precise, painstaking.

A mind capable of performing only one of these five functions is an elementary one. As it is capable of performing two or more, it is complex. Commonly you find men capable of only one; frequently of two; occasionally of three; rarely of four; hardly ever of all five.[1]

Here, then, if we assume the correctness of this theory as to the way every task naturally breaks down and as to the natural capabilities of men, is evidence of the sound psychological basis of Taylor's subdivision of the work of a shop. And it is to be understood that the theory in question not only represents an extensive observation, but also has met the test of an extensive practice.

Now, in considering the effect of the functional principle upon management positions of the higher or general type, we must realize that this principle by no means applies solely to the shop, or to an organization specifically devoted to some

[1] For this statement of the case the writer is indebted to J. E. Otterson.

form or process of manufacturing. These days it has come to be applied not only to each of the departmental organizations within an establishment, but also to the organization as a whole. Every organization, whether it be an elementary one or one including within itself other organizations, must have a task, must exist for the accomplishment of certain definite results; must, in a broad sense, produce something. Consequently the general phenomena of one organization repeat themselves in all organizations. Whatever the task, it naturally breaks down into the principal functions of planning, preparation, scheduling, production, and inspection. As tasks differ, the specific things involved in each of these functions may differ, and the relative importance of the functions may differ, but the general nature of each remains the same.

In his Harvard lectures, delivered toward the close of his life, Taylor said:

> More and more, as scientific management develops, are the purchasing, the sales, and the collection and advertising departments being managed along functional lines. It must be said, however, that in the work of these departments, and in the sales department particularly, the military type of organization still predominates.

He personally did not extend the functional principle much beyond the shop, and it was because of this that he drew from the shop practically all of his illustrations when describing its workings. But, as his words just quoted show, it is a mistake to argue from this that his *vision* was limited to the shop. Surely he would be gratified to know what has been done since his death to functionalize selling.

Proceeding on the basis of the analysis of function here given, we must conclude that it is as a man is capable of more than one of these functions, or as his mind is complex, that he really is capable of holding the higher positions in management. The term *general* manager indeed implies one having an outlook upon *all* the steps in the accomplishment of an organization's task.

Manifestly, this does not appear while the management remains at that stage represented by a simple and unconscious following of tradition. Thus, under traditional management, all the members of an organization can more or less readily make a bluff at filling their positions. And as greater complexity of mind is needed in proportion to the height of the position, and men of the greater complexity are comparatively rare, the likelihood of finding bluffers is increased the higher up you go; and this all the more because nepotism and other forms of favoritism are especially likely to dictate the choice of men for the higher positions. The moment, however, that a clear definition of functions begins, all bluffing is threatened; with this clear definition inevitably comes a precise fixing of responsibility.

It is true that the holder of a general position need not and cannot well be expert in all the functions his position overlooks. His position being general, he should concern himself with general principles and methods, and should not, as Taylor expressed it, " mess into the details." And Taylor added:

> The shop, and indeed the whole works, should be managed, not by the manager, superintendent, or foreman, but by the planning department. The daily routine of running the entire works should be carried on by the various functional elements of this department, so that, in theory at least, the works could run smoothly even if the manager, superintendent and their assistants outside the planning room were all to be away for a month at a time.[1]

Further light on Taylor's conception of the position of the general manager will be cast by what he wrote concerning a principle that was among his most important:

[1] *Shop Management*, p. 110.

> What may be called the "exception principle" in management is coming more and more into use, although, like many of the other elements of this art, it is used in isolated cases, and in most instances without recognizing it as a principle which should extend throughout the entire field. It is not an uncommon sight, though a sad one, to see the manager of a large business fairly swamped at his desk with an ocean of letters and reports, on each of which he thinks that he should put his initial or stamp. He feels that by having this mass of detail pass over his desk he is keeping in close touch with the entire business. The exception principle is directly the reverse of this. Under it the manager should receive only condensed, summarized, and *invariably* comparative reports, covering, however, all of the elements entering into the management, and even these summaries should be carefully gone over by an assistant before they reach the manager, and have all of the exceptions to the past averages or to the standards pointed out, both the especially good and especially bad exceptions, thus giving him in a few minutes a full review of progress which is being made, or the reverse, and leaving him free to consider the broader lines of policy and to study the character and fitness of the important men under him.[1]

Here also is this statement from Taylor's Harvard lectures:

> The broad application of the exception principle is, of course, only possible with modern scientific management, in which everything is done in accordance with laws and rules; because if the workmen and the foremen are not working according to laws or rules, there is no standard, such as the task, which draws a sharp line between failure and success. If there are no rules, there can be no exceptions.

The fact that the general manager must deal with these exceptions, "consider the broader lines of policy," and "study the character and fitness of the important men under him" clearly signifies that, while he need not be expert in all the functions his position overlooks, his mind should be sufficiently complex to *comprehend* all of them. He should have in him

[1] *Ibid.*, p. 126.

something of both the executive and the engineer. That in Taylor's day managers with any engineering training were few and far between, should by itself serve to explain most of his difficulties.

But it was not only the bluffing manager who was antagonized by the functional principle. Taylor's various statements about the effect of this principle on the position of the general manager all come down to the fact that functionalization means decentralization, or the removal of "local and special" functions from the general manager's *immediate* direction and control. Thus Taylor's insistence on this principle also antagonized the man who, trusting only himself, is fussily concerned about the work of others, and the man who wants to be the whole thing so that he may feel big.

Lastly, as Taylor's functional principle stripped management positions of their plenitudinary authority, the general manager's along with the rest, and as it based all authority on knowledge and made the idea of authority entirely subordinate to the idea of responsibility, it menaced every tyrant, or every man who would govern according to his caprice, his arbitrary will.

CHAPTER XI

TAYLOR'S WAGE PRINCIPLES AND METHODS

HOW far he progressed with the functional principle at Midvale may be gathered from this quotation from his paper of 1903, *Shop Management:* [1]

> The writer introduced five of the elements of functional foremanship into the management of the small machine shop of the Midvale Steel Company of Philadelphia while he was foreman of that shop in 1882–1883: (1) the instruction card clerk, (2) the time clerk, (3) the inspector, (4) the gang boss, and (5) the shop disciplinarian. Each of these functional foremen dealt directly with the workmen instead of giving their orders through the gang boss. The dealings of the instruction card clerk and time clerk with the workmen were mostly in writing, and the writer himself performed the functions of shop disciplinarian, so that it was not until he introduced the inspector, with orders to go straight to the men instead of the gang boss, that he appreciated the desirability of functional foremanship as a distinct principle of management.

To this he immediately added:

> The prepossession in favor of the military type was so strong with the managers and owners of Midvale that it was not until years after functional foremanship was in continual use in this shop that he dared to advocate it to his superior officers as the correct principle.

It is significant that in his paper of 1895, *A Piece-Rate System*, he said not a word about functional foremanship. The fact is that, probably owing to the bitter opposition it aroused, he himself was somewhat uncertain about it at this

[1] P. 107.

time, and it was not until after he went to Bethlehem in 1898 that all his doubts were removed.

His instruction-card clerk and time clerk at Midvale composed what he called the rate-fixing department, and that, as a matter of fact, was all that his planning room then amounted to, save as it had existence in his own head.

A "time note" found among his effects shows that he started to apply the principle of time study to the routine work of his rate-fixing office itself. One clerical task was resolved into such elements as "enter tires in records from standing order," "post wages earned by men on mills and fix bonus," and "file and put away records of finished tires," and a definite time was allowed for doing each of these things. Since Mr. Taylor's death there has been some discussion as to who first got the idea of applying his principles to office work; this "time note" shows that he himself had the idea back in the 1880's.

Referring to his rate-fixing department, he wrote:

> This department far more than paid for itself from the very start; but it was several years before the full benefits of the system were felt, owing to the fact that the best methods of making and recording time observations of work done by the men, as well as of determining the maximum capacity of each of the machines in the place, and of making working-tables and time-tables, were not at first adopted.[1]

We come now to the details of the way he induced his men to perform the definite tasks that, with the development of his working tables and time tables, he was able to assign them.

It already has appeared that he accomplished this mainly through the promise of high wages; and the fact is that as men started to work regularly in the new way of turning axles and tires, a piece rate was fixed for them that was designed, apparently, to enable them to earn regularly at least

[1] *Ibid.*, p. 149.

a third more than they had been earning. And here it is to be brought out that after the years during which he was continually quarrelling with his men, it became his policy in dealing with workmen to avoid any reference to their doing more or better work; that is, he deliberately sought to fix their attention, not on what they were going to give, but on what they were going to *get*.

In dealing with the high-grade mechanics at Midvale, he thoroughly explained the purposes of his innovations, and had no difficulty in enlisting their coöperation. As one of his old men has expressed it, his "scientific method of obtaining data" seemed to insure that the company would have "no reasonable grounds for cutting the rate." These highly intelligent men well understood why rate-cutting in the past often had been unavoidable, and were inclined to believe that Taylor's methods would enable them to earn higher wages *permanently*. Moreover, suspicious as they might be of the whole race of employers, they knew that a Fred Taylor promise was valid.

With the majority, however, he could not explain; they having an unreasoning fear of all innovation, or being opposed to all change *as* change, or having a well-nigh incurable belief (which you hardly could call unreasonable in view of their past experience) that as an employer would not introduce a change which was not in *his* interests, any change he sought to bring about must be against *their* interests. In dealing with these men, Taylor developed a definite technic and became a master hand in applying it. This lay along the lines of picking out one or two of the more intelligent and ambitious, bringing all his powers of persuasion to bear on them to get them started, keeping them under firm pressure until they had grown accustomed to the new way of working, and then relying on the object lesson they afforded to win over the other men.

Again we quote from the testimony taken by the Special House Committee; and when Mr. Taylor speaks, we shall be justified in picturing him with his mischievous little twinkle in his eye:

> The Chairman. Isn't it part of the scientific management, or the Taylor system, to bring all the powers of the management to bear on the individual in order to compel the individual to carry out the policy of the management?
>
> Mr. Taylor. With the first man whom you tackle in a shop and want to teach and bring from the old method of doing the work to the new method, as a rule, I think you can say that you do bring heavy pressure to bear on the man. You are very apt to put three or four teachers around him at once to see that he does not skip out from under anywhere. You understand, of course, that is true of the first man. Under scientific management our procedure is to get one man working under the new conditions and at the proper pace, and then let him go right on earning his premium of 30 per cent to 100 per cent until he wants the new system badly. And invariably some friend of his — generally not one friend only, but a dozen of them — will come and ask for the same thing. When the men see a friend of theirs, right alongside of them, working practically no harder than they are working, but merely obeying certain instructions and directions given him and thereby becoming more efficient and doing the work quicker — when they see that man getting 30 to 100 per cent higher wages than they are getting, they want some of that velvet. The other men throughout the shop themselves come and ask for the new system. When scientific management is properly introduced, almost invariably we wait for the men to come and ask to work under the new plan.

He frequently was asked in later years how, in fixing premiums or bonuses for the accomplishment of his scientifically-set tasks, he arrived at his figures of "from 30 to 100 per cent." His answer was that this also had been the subject of a scientific investigation, that he had determined by careful experiments that such were the percentages which would compensate men for the irksomeness involved in changing their habits of working and would keep them contented and happy in the doing of their tasks. The range in the percentage was due to the fact that it must be increased as the work done partook of the hard or disagreeable. Undoubtedly he did resort to some formal experimenting with various percentages, but that he was justified in calling these experiments scientific may fairly be open to question. It is certain, however, that his percentages were rational deductions from facts of observation and experience.

Even before he had begun at Midvale to fix tasks based on scientific investigation, he hit upon that modification of the "straight" piece-work system that he called the differential rate, and so it was that the first wage-increases under Scientific Management were in the form of this rate. In his paper of 1895 he explained its workings as follows:

> This consists briefly in paying a higher price per piece, or per unit, or per job, if the work is done in the shortest possible time, and without imperfections, than is paid if the work takes a longer time or is imperfectly done.
>
> To illustrate: Suppose 20 units or pieces to be the largest amount of work of a certain kind that can be done in a day. Under the differential rate system, if the workman finishes 20 pieces per day, and all of these pieces are perfect, he receives, say, 15 cents per piece, making his pay for the day $15 \times 20 = \$3$. If, however, he works too slowly and turns out say, only 19 pieces, then, instead of receiving 15 cents per piece he gets only 12 cents per piece, making his pay for the day $12 \times 19 = \$2.28$, instead of $3 per day.
>
> If he succeeds in finishing 20 pieces, some of which are imperfect, then he would receive a still lower rate of pay, says, 10 cents or 5 cents per piece, making his pay for the day $2, or only $1, instead of $3.

Whether or not it clearly appears in this illustration, the fact is that if his higher or highest rate was designed to enable the workman to earn unusually high wages, his aim was to fix his lower rate or rates at figures that would "allow the workman to earn scarcely an ordinary day's pay," and so have a system that not only would reward the workman for accomplishing his tasks, but also would punish him unmistakably for failing to accomplish it. As he expressed it in his later paper, *Shop Management*, his differential-rate system "not only pulls the man up from the top, but pushes him equally hard from the bottom." Every means would thorough-going Fred Taylor take to get his tasks done and done right.

However, he never had a pride of authorship in his differential system such as prevented him from adopting other wage-payment methods shown to be, under particular circumstances, more feasible if less rigorous; and the fact is that though he clung to the theory of the differential, he never again found occasion for making use of it after leaving Midvale. With him the important thing always was the principle of extra pay for extra work.

The wage philosophy that always governed his practice, whatever the particular wage system he might employ, may be summed up in this proposition: that current wage-rates are approximately just compensation for the character of production under which these rates have grown up, but are not just compensation for the character of production obtained through a scientifically set task, and that the proper extra pay for the extra effort called for by a scientifically set task is that which will induce the worker to make the extra effort continuously.

Some of Taylor's friends in academic circles, particularly professors of economics, questioned the scientific nature of any wage system based on current wage-rates. Such rates, they said, grow up largely at haphazard, and as regards localities are subject to variations having no rationale. While Taylor regarded the principle of extra pay for extra work as a universal one, it is not on the record that he considered his general method of applying this principle as perfect. Here again, as a practical man, he had to be content with approximations, had to figure that the scientific way is simply the best way that, in view of all the facts, a thing can be done at any particular time and place. Certainly he had the satisfaction of knowing that his general method of determining wages met in his time the pragmatic test — *it worked.*

Just why it worked will be clear when his way of dealing with labor is contrasted with the traditional way.

This latter way was for the manager to say to the worker, in effect: I know that all you can earn is [say] two dollars a day, for I always can get men of your grade in this locality to work for that sum. It is true I haven't any clear idea of what you in return ought to give me — I shall have to leave that largely to you — but if you don't give me as much as two-dollar men usually give me, I shall fire you, and if I can drive, trick, or cajole you into giving me more, I shall do so.

Such a method naturally led to warfare; and at the bottom of the difficulty, as shown by Taylor's analysis, was the manager's ignorance of the amount of work the worker should do. What the manager bought or thought he was buying was the worker's *time.* At the best he had only a hazy notion that time is but the package in which effort, the real goods, is wrapped. Either he failed to realize the big difference in effort that can be put forth in an interval of time such as a day, or he went blundering along under the delusion that he could command the best effort without paying the price.

On the other hand, Taylor clearly saw that the real goods is the worker's effort, and that to get the best effort the manager must *specify* it and offer a price for it that would induce the worker to deliver it. Hence, under his system, the manager said to the worker, in effect: I want you to help me produce a certain amount every day. Your part will call for your exerting yourself just in this way and just to this extent. Watch me do it, and you will see that, as a man who is adapted to the job, you can easily do it or be taught to do it.[1] Now you understand just what I want from you. For a day's work of this kind I will pay you [say] $3, for I always can get men of your grade to make this effort for this sum. You must understand that if any day you fall short of this effort, I will pay you only $2, the ordinary rate for ordinary work. On the other hand, if you are such an unusually able workman that you can do more in a day than I require, I will pay you for it, so that you will share in the extra production to the same extent that you do in the required production.

As Taylor's years of experience proved that here was established a mutuality of interest to which all kinds and conditions of working people responded, he was not without justification in believing that he had established a basis for a solution of the labor problem. He saw that the traditional method of buying labor meant either low wages with high labor costs when the employer was "top dog," or higher wages with still higher labor costs when the workman was on top. He believed that, buying on specification, Scientific Management made it to the interest of the worker to deliver the best quality of work, and that, *with its mechanism for utilizing the full value of this work,* it combined the highest wages known in the industrial world with the lowest labor

[1] Behind this sentence is far more than may appear. Says H. L. Gantt in *Industrial Leadership:* "The authority to issue an order involves the responsibility to see that it is properly executed. The system of management which we advocate is based on this principle, which eliminates bluff as a feature of management, for a man can only assume the responsibility for doing a thing properly when he not only knows how to do it, but can also teach somebody else to do it." It should not be difficult for anyone to understand why working people, apart from any question of wages, found it a satisfaction to work for men who could *show* them as well as tell them, and who incidentally assumed the responsibility for the implements and all the conditions upon which the fulfillment of the tasks depended. It undoubtedly was because of this as well as of the high wages he paid that Taylor never again had any trouble with working people after his early experience at Midvale.

costs. High wages with low labor costs became one of his great principles. And here he set up both for the employer and the employee the principle of giving. He felt that when both parties to a contract are bent on giving, not as little as possible, but as much as is feasible under all the circumstances, neither stands to lose and both stand to win.

He, of course, did not advocate that the employer should pay wages as high as his financial resources might permit. It was Taylor's inference from experience that workmen could be over-paid; that, especially among the mass of unskilled workers, any great increase of wages, coming suddenly, is likely to prove demoralizing; that there are thousands of persons who, because they have a low standard of living and no habit of thrift, view an opportunity to earn more money simply as an opportunity to work less. But the principal reason why he did not advocate that the employer should pay wages as high as his financial resources might permit was that this would prevent the realization of the other half of the ideal; namely, low labor costs.

Many of those persons who heartily supported him in his belief that capital and labor have an equal interest in increasing production, could not follow him in his belief that the interests of capital and labor are identical when it comes to the division of the profits arising from production.

We gather that the reasoning which supported his sublime faith that, even as regards the division of the product, there need be no quarrel between capital and labor was this: The capitalist and the laborer have an equal interest in keeping prices low. The lower the price, the greater the sale. The greater the sale, the greater the employment both for capital and labor. The capitalist and the laborer, moreover, are both consumers. Jointly they are consumers of the materials and implements entering into their production. Individually they are consumers of eatables, wearables, and other things we call ultimate products. Thus not only as producers but also as consumers they are equally interested in low prices. An important factor in price is labor cost. Thus capital and labor have an equal interest in the maintenance of a wage system scientifically designed to reduce labor costs and keep them low.

CHAPTER XII

TOWARDS INDUSTRIAL DEMOCRACY

HE applied his principle of extra pay for extra work not only to the piece work at Midvale but also to the work which was of such a nature that it had to be kept on a day-work basis. He paid the men who did this latter work, not according to the positions they held or their classification as mechanics or laborers, but according to their individual character and skill. A systematic record was kept of each man's "punctuality, attendance, integrity, rapidity, skill, and accuracy," and from time to time the men's wages were readjusted in accordance with this record.[1]

Evidently his systematic individualization of all workmen largely was inspired by his desire to avoid among them any tendency to unionism. In his paper of 1895 he wrote that in the previous ten years the steel business had proved "the most fruitful field for labor organization and strikes," and he went on to say that "when men throughout an establishment are paid varying rates of day-work wages according to their individual worth, some being above the average and some below the average, it cannot be for the interest of those receiving high pay to join a union with the cheap man." He fully, you might say enthusiastically, recognized that when workmen are treated as a herd their only remedy lies in combination and "frequently in strikes," but he himself proposed to avoid the disease that made the remedy necessary; and if he was *anxious* to do this, it was because he saw that the tendency of

[1] Paper of 1895, *A Piece-Rate System.*

unionism in his day was invariably to make the work of the least efficient man the standard of the shop and in general to restrict output.

How mixed his sympathies were in connection with unionism may be gathered from the fact that, though in his paper of 1895 he singled out the trade unions of England for mention as having "rendered a great service not only to their membership, but to the world," he in his Midvale years had reason to lament what this same English trades-unionism had done to make the workers of that country believe in limiting output. It was the English mechanics at Midvale who had most stubbornly upheld the "systematic soldiering" there. This he mentioned in a letter he wrote in November, 1913, to J. Ellis Barker, an English publicist who, in an article in the *Fortnightly Review*, had taken an alarming view of industrial conditions in his country.

Your report [said Taylor] would lead one to conclude that England's lack of output was mainly due to inferior machinery and to the use of too small an amount of horsepower, etc. I know case after case in England where they use exactly the same machines as in this country, but at far less horsepower and at far less speed than they should be run, and in a manner so as to turn out nothing like half the work that is being turned out in this country; and this is due, not to the lack of proper machinery, but to the almost unalterable determination of every workman in England to turn out as little work as possible each day in return for the money he receives. This with the English workmen is almost a religion.

In 1882, when I was foreman in the machine shop of the Midvale Steel Co., I first became thoroughly convinced of this fact. At that time the steel business in this country was comparatively in its infancy, and it was impossible for us to get skilled American workmen to carry on the steel business. There was at that time quite a large English immigration of skilled steel workers to this country, and we had to depend for some time upon these men to do our work. At that time there were no trades unions in the steel business to speak of in this country (at least they were not powerful). In spite of this fact, however, I soon found that every English workman was doing everything in his power, first, to restrict his own output, and, second, to induce every other workman around him to restrict output to the maximum possible extent. . . .

To illustrate this restriction of output, we had in our works a locomotive and car wheel tire rolling machine, which was bought from Tangy Brothers in England, and all the apparatus connected with this machine came from England. We had a splendid set of English workmen — that is, they were fine fellows and very skilled workers — to run this machine. And after working at it for three or four years, they would only turn out about 15 tires per day. We called their attention over and over again to the fact that at this rate of production we were making no profit whatever; that it was absolutely necessary to increase the production of this machine. All of our persuasion and all of our talk was of no avail whatever, and we were finally obliged to discharge the whole lot of them, get every man outside of the works, and ourselves to train in an entirely new and green set of American workmen, who had never seen a machine of this sort. Within three months after training them in, we had increased the output from 15 to 25 tires a day, this output went on, right on the same machine, increasing until three or four years later we had an output of 150 tires a day.

The big jump in the production of this rolling machine came when the horsepower used in it was "immensely increased" and the men running it were put under Taylor's differential-rate system; and from his paper of 1895 we quote what happened when this system was applied to a typical piece of lathe work:

A standard steel forging, many thousands of which are used every year, had for several years been turned at the rate of from four to five per day under the ordinary system of piece-work, 50 cents per piece being the price paid for the work. After analyzing the job and determining the shortest time required to do each of the elementary operations of which it was composed, and then summing up the total, the writer became convinced that it was possible to turn ten pieces a day. . . .

It will be appreciated that this was a big day's work both for men and machines, when it is understood that it involved removing, with a single 16-inch lathe, having two saddles, an average of more than 800 pounds of steel chips in ten hours. In place of the 50-cent rate that they had been paid before, they were given 35 cents per piece when they turned them at the speed of 10 per day, and when they produced less than 10, they received only 25 cents per piece.

It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of $3.50 per day. But from the day they first turned ten pieces to the present time, a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time, until the beginning of the recent fall in the scale of wages throughout the country, the rate was not cut.

Incidentally it may be mentioned that the cost of turning these pieces was reduced from a dollar and seventeen cents each to sixty-nine cents.[1]

In the case of all his piece-rate workers he found, as he wrote, that it was not

[1] One of the curious incidents of Taylor's career was that some time after 1910, when wide publicity was given to his general methods, a preacher of ethical culture stood right up in meeting and denounced such results as these as scandalous. How he and persons like him reach their conclusions is so childlike in its simplicity that he who runs may grasp it. In such a case as that of the Midvale forgings they would fix their attention on the fact that the machinists turned ten a day instead of five; from this they would leap to the conclusion that those machinists did twice as much work, and then they would argue that those who do twice as much work ought to get twice as much money. Hence if those machinists got $2.50 a day when they turned five forgings, it was a sin and a shame that when they turned ten they did not get $5 a day, but only $3.50. Remote from industry, these good people have little or no idea of the part that better planning may play in increasing a workman's production and what this better planning costs the management. During Taylor's active career, he, of course, could not have made any headway if he had not kept constantly in mind the need of reimbursing his employers for the cost of his experimenting as well as of the system needed to maintain the standards developed by the experimenting.

> . . . sufficient that each workman's ambition should be aroused by the prospect of larger pay at the end of even a comparatively short period of time. The stimulus to maximum exertion should be a daily one.
>
> This involves such vigorous and rapid inspection and returns as to enable each workman in most cases to know each day the exact result of his previous day's work — i.e., whether he has succeeded in earning his maximum pay, and exactly what his losses are for careless or defective work. Two-thirds of the moral effect, either of a reward or penalty, is lost by even a short postponement.

In all particulars he strove to adapt his system to working people as he found them, and evidently he found that their greatest weakness was their tendency to live wholly in the present. To look ahead, to visualize the future, to sacrifice a present satisfaction for a later and greater one — this, though a fundamental to progress, is apparently about the hardest thing that the mass of workers can do. Hence the stress Taylor put, not only on immediate rewards, but on still more immediate returns.

It will be understood that in speaking of the mass of workers we are speaking of the mass of humanity. In the ranks of labor, of course, there always have been hundreds of men so intellectually keen, so willing, so progressive that they naturally rise to high positions of leadership. And in the mass exists as a potentiality what in exceptional men is the actuality. All democratic men *feel* this, and act accordingly. And it was so with Taylor. He saw that wisdom ceases and folly begins when men whose potentialities remain undeveloped are treated as if their potentialities were fully developed. But it is safe to say that never was there an exceptional man who strove harder than he to help others to make their potentialities actual. As a manager he was his own labor leader. In truth, he never could be cured of the idea that leading its own employees is one of the natural functions of management; it was inherent in his philosophy that it is only as management neglects this function, or is incapable of exercising it because of its own lack of development, that the rank and file must look for leadership elsewhere.

In H. Fawcett's *Political Economy*, published in 1874, the year before Taylor began his industrial career as an apprentice, it was written: "No remedy for low wages can be really efficient unless it increases the efficiency of labor and secures a social and moral improvement in the condition of the laborers themselves." Though it is improbable that Taylor ever saw these words, they might well have served as a text for all that part of his work in management pertaining to the "labor end."

When he entered industry, no such thing as industrial democracy was conceived of. The most successful managers of that day relied upon force or coercion almost pure and simple. As he "confided himself childlike to the genius of his age," Taylor was strong. But the great difference between him and the ordinary manager of that day was that he, throwing himself into his work with extraordinary sincerity and zeal, was thereby quickly brought face to face with the limitations of force; this term here being used to stand for the general idea of external pressure, or anything which acts as a threat or suggestion of harm or loss and so arouses fear.

He never abandoned his belief that force, to a greater or less degree, must be retained in the management of men. Writing in 1913 (two years before his death) to Edwin F. Gay, then dean of Harvard's Graduate School of Business Administration, he said:

> The great trouble with the men who have been too many years getting an academic education is that they have not had the experience in being obliged to "get there." If they understand the theory of the thing and feel thoroughly convinced that such and such a

proposition is right, they almost invariably attempt to get other men to do what they ought to do by reasoning, persuasion, and talk, and by giving them orders and directing them what to do. And this way of dealing with men, as I have said many times, is productive of very small results. I have found it necessary almost invariably to talk but little to men, but to go right ahead and MAKE [his capitals] them do what I wanted them to do, and this implies the experience of knowing how, by hook or crook, to get men to do what at the time they do not wish to do. It is part persuasion and part force, and the presentation of actual object lessons of various kinds, and the academic man neither understands nor believes in the use of this sort of force.

This points to the limitations of force as he discovered it. He found that you could not by any means rely on it alone to draw from men their best efforts. More specifically, he found that the use of force is economically feasible only when, as supplemental to appeals to self-interest and to reason, it is used to get men to do what they know is right, proper, and in line with their own interest, but have not the strength to initiate of their own volition; or when it is used to get men to do what they *will* recognize as right, proper, and in line with their own interest when they *come* to do it. It was with him a regular engineering proposition. He learned as a result of his long fight with his men at Midvale, that to try to force men to do what they regard as against their interests is to subject management to a strain that cannot be continued indefinitely. However, if what the management forces the men to do must eventually commend itself to them, this force will have to be exerted only temporarily.

While it was with him an engineering or economic proposition, he at the same time found it an ethical one; it also being brought home to him in consequence of his fight with his men that shops or works management, when it really did rule, was compelled to rule, as conditions then were, through a use of force that clearly should be unnecessary if only because it was morally shocking.[1] And here his attitude was that of the practical idealist.

To say that a thing should be unnecessary is not the same as saying that it *is* unnecessary. It may be necessary on account of existing conditions. The fact, however, that we can see that a thing should be unnecessary implies our recognition of the fact that the conditions which make it necessary have no call or right to exist and therefore should be expunged as fast as may be possible. The "should be," in fine, stands for the ideal. And an idealist is one who recognizes the validity of the ideal. The impractical idealist, however, ignores the conditions that make a thing necessary, and thus assumes that what should be unnecessary is unnecessary. On the other hand, the practical idealist *faces* the conditions that make a thing necessary, seeks to expunge these conditions, and considers that what should be unnecessary is unnecessary only to the extent that these conditions are expunged.

Thus Taylor, if he came to realize that force should be unnecessary in the management of men, did not cease to use it, but while continuing to use it, attacked the conditions that made it necessary. In the manuscript he prepared in 1909 for his Harvard lectures, we read:

> The management of workmen consists mainly in the application of three elementary ideas:
>
> *First.* Holding a plum for them to climb after.
>
> *Second.* Cracking the whip over them, with an occasional touch of the lash.
>
> *Third.* Working shoulder to shoulder with them, pushing hard in

[1] If the implication here is that management *should* rule, it is to be recognized that this proposition has nothing to do with any dispute between "capital and labor" or any question as to who should own or control industry. No matter who owns or controls, some persons must plan and others execute, some must order and others obey. It is to be recognized also that a stern belief in the authority of management is quite consistent with a belief that the employees should participate in the management, have a voice in determining its policies, and so on.

the same direction, and all the while teaching, guiding, and helping them.

The management of the present consists of a combination of the first two of these elements, and of these the plum is more effective than the lash, although the latter is too often applied. Scientific Management, the management of the future, consists in the application of all three elements, the lash, however, being left almost out of sight, while the close, hearty coöperation of the management with the workmen becomes the most prominent feature, and a good big plum is kept always in sight.

In his vivacious language, the "plum" symbolized the appeal to self-interest, and the "lash" the appeal to fear. He felt, in 1909, that the lash had generally become subsidiary to the plum. But in the management of the future there would be little or no need of any appeal to fear. Such was his vision.

At Midvale, he early brought to the front the principle of the plum. This, however, was in the form of a differential rate that embodied the appeal to fear along with the appeal to self-interest. As Taylor expressed it, the principle was that of "high pay for success" and "loss in case of failure."

Again he found, in the case of many of his men, that it was not enough to hand them written instructions and point out that they would financially profit or suffer as these instructions were or were not followed. To supplement this automatic system of reward and punishment, there must be, right with the workmen on the floor of the shop, foremen whose special duty it was to make plain that if those instructions were in the nature of a call to dinner, it was the purpose of the management to see that *every man* responded to the call. That is to say, the science of the work and the workman *must* be brought together.

Developing a science amidst the every-day work of the shop, Taylor naturally clung to current shop terms, even if they were not those either of academic shades or of polite society. So he called his shop-floor functional foremen "speed bosses," "gang bosses," and so on. The speed boss never was a monster whose function it was to "speed 'em up" until the workmen were ready for a human scrap heap. In the days when instruction cards still were rudimentary, instructions in following the best practice as regards the speeding of machines and the use of small tools were given largely by word of mouth, and the speed boss was so called because he was the expert in these things.[1] At Midvale, Taylor was his own speed boss. He and his gang boss, however, were at the beginning largely bosses plain and simple.

But water continued to flow under the bridge; which is to say that Taylor, as he put the work of the shop more and more on a scientific basis, found that the workmen would have to be more and more carefully selected for their particular tasks and to an increasing degree trained and instructed. At the same time, he found that as his men got into the swing of the new way of working, that as they passed the irksome period during which they had to change their habits, they became less and less in need of external pressure and became more and more their own pressure-producers. Thus the bosses, though they retained the title, became less and less of the boss and more and more of the teacher; so that when he prepared his Harvard manuscript about twenty years after he left Midvale, Taylor could write:

> In performing their duties, these teachers of the men are guided by the written instructions of the planning department just as much as the workmen are. They, however, study all of the work in advance of the workmen, and in attending to their duties they act not as driver and task master, but rather as guide, philosopher and friend.

[1] This boss of course had to consider the rate at which the metal was fed to the tool as well as the speed at which the tool was run, and as the feed was the thing of the greater importance, it has been suggested by Barth that he might better have been called the "feed boss."

Their work is that of teaching and helping the men, watching over them, and finding their weak points, and then correcting them by example and by actually doing the work themselves while the workmen look on, as well as by talking to them.

In this same manuscript, he summarized the work of his functional foremen as follows:

The planning department analyzes in advance the job for the workman, giving him written orders, telling him in the most minute detail each motion which he is to make, and the time in which he is to do it. All the implements the workman is to use are not only specified but systematically brought to him before he starts to work. Each implement so furnished should be the very best known in the art for its particular purpose, and should always be kept in perfect order by the tool-making department. Every operation of the machine which he is to run is in the same way studied in advance. Written directions covering the details of running the machine are given the workman, accompanied by a time table, similar to the time table for the workman's own motions. As the workman proceeds with a job, several teachers, one after another, come to him at his machine, and show him just how each motion is to be made in the most effective way. One of these teachers (called the inspector) sees to it that he understands the drawings and instructions for doing the work.

He teaches him how to do work of the right quality, and how to make it fine and exact where it should be fine, and rough and quick where accuracy is not required, — the one being just as important for success as the other. The second teacher (the gang boss) shows him how to set up the job in his machine, and teaches him to make all his personal motions in the quickest and best way. The third (the speed boss) sees that the machine is run at the best speed, and that the proper tool is used in the particular way which will enable the machine to finish its product in the shortest possible time. In addition to the assistance given by these teachers, the workman receives orders and help from four other men; from the repair boss as to adjustment, cleanliness and general care of his machine, belting, etc.; from the time clerk, as to everything relating to his pay and to proper written reports and returns; from the route clerk, as to the order in which he does his work and as to the movement of the work from one part of the shop to another; and finally, in case a workman gets into trouble with any of his various bosses, the disciplinarian interviews him.

It must be understood, of course, that all workmen engaged in the same kind of work do not require the same amount of individual teaching and attention from the functional foremen who are over them. The men who are new at a given operation naturally require more teaching and watching than those who have been a long time at the same kind of jobs.

Here we can see how he sought to make everything conspire to help the workman increase his individual production. This increase of production, he felt, was in the interest of all men. But he wanted everything in his system brought down to the workman not simply because of the increased production. A large part of his desire for this was due to his interest in workmen as human beings; and as regards this very important point we must give him his full say.

Now [he continued in his Harvard manuscript] when through all of this teaching and this minute instruction, the work is apparently made so smooth and easy for the workman, the first impression is that this all tends to make him a mere automaton, a wooden man. As the workmen frequently say when they first come under this system, "Why, I am not allowed to think or move without someone interfering or doing it for me!" The same criticism and objection, however, can be raised against all other modern sub-divisions of labor. It does not follow, for example, that the modern surgeon is any more narrow or wooden a man than the early settler of this country. The frontiersman, however, had to be not only a surgeon, but an architect, house-builder, lumberman, farmer, soldier, doctor, and he had to settle his law cases with a gun. You would hardly say that the life of the modern surgeon is any more narrowing, or that he is more of a wooden man, than the frontiersman. The many problems to be met and solved by the surgeon are just as intricate and difficult and as developing and broadening in their way as were those of the frontiersman. The workman who is coöperating with his many teachers under the modern scientific management has at least the same, generally a greater, opportunity to develop in an intellectual way as he had when the whole problem was up to him and he did his work entirely unaided.

If it were true that the workman would develop into a larger and finer man without all of this teaching, and without the help of the laws which have been formulated for doing his particular job, then it would follow that the young man who now comes to college to have the help of a teacher in mathematics, physics, chemistry, Latin, Greek, etc., would do better to study these things unaided by himself. The only difference in the two cases is that students come to their teachers, while from the nature of the work done by the mechanic, the teacher must go to him. What really happens is that, with the aid of science which is invariably developed, and through the instructions from his teachers, each workman of a given intellectual capacity is enabled to do much higher, more interesting, and finally more developing and more profitable kind of work than he was before able to do. The laborer who before was unable to do anything beyond, perhaps, shoveling and wheeling dirt from place to place, or carrying the work from one place to another in the shop, is in many cases taught to do the more elementary machinist's work, accompanied by the agreeable surroundings and the interesting variety and higher wages which go with the machinist's trade. The cheap machinist or helper, who before was able to run perhaps merely a drill press, is taught to do the more interesting and higher priced lathe and planer work, while the highly skilled and more intelligent machinists become functional foremen and teachers. And so on, right up the line.

As I have several times before tried to point out, the value of any system of treating or managing workmen should be measured chiefly by the effect which it has in the long run upon the character of the workman as well as upon his prosperity.

The lives of men in any class are more affected by the habits which they form than by any other one influence. It is my observation that good principles usually follow good habits, instead of the reverse. The best way to secure good principles in men, therefore, is to firmly establish them in good habits. Now, perhaps the most prominent characteristic of modern scientific management is the task idea which pervades it. Each workman is each day given in advance a carefully thought-out and well-rounded task, a task which demands in him personal excellence, not only in one particular, but a thorough and fine balance of the several qualities which together make a man.

Since the best possible series of movements are carefully thought out for him, in all cases, by a man trained to methodical thinking, the workman soon gets into the habit of looking for some logical system, some philosophy back of the doing of each job. There is no doubt left in his mind that among the fifty possible ways of doing each little thing, there is always one best way, and he gets in the habit of not only knowing what the best way is, but of trying to find out just why it is best, and of then practising this method until he becomes physically dexterous at it. He learns, also, that one particular implement is always better than the other forty-nine that might be used, and he is taught the reason for this superiority. He soon recognizes the vital importance of planning ahead all the way through to the end of each job; and the habit of doing all of these things with a certain method and swing makes him more logical and trains him to more exact and precise thinking.

This intellectual improvement, or improvement in the mental processes of the workman, and the manual skill which he acquires, are, however, of less importance than the change which takes place in other directions under the pressure of the task, and through the help and guidance of his teachers. Of even greater importance than training him to think clearly is the fact that he is taught not only to be careful and to use exact methods, so as to do accurate work, but at the same time to use energy and constant diligence to do the amount of work required of him in a given time. This develops in him, at the same time, the several qualities which makes him a well-rounded, well-balanced and successful man. Because the successful workman of today must have all four qualities, in even balance, of (1) knowing how to do, (2) possessing the manual dexterity, (3) using constant care, and (4) having the speed to work fast and the energy to keep it up. If he lacks any one of these four qualities he will be a failure, instead of a success.

The setting of a task draws in each case a clear-cut, sharp line between success and failure. When the workman succeeds in crossing this line, he receives an addition of from 30 to 100 per cent to his pay, so that a large inducement is offered him each day to be successful.

The moral effect of this habit of doing things according to law and method is great. It develops men of principle in other directions. When men spend the greater part of their active working hours in regulating their every movement in accordance with clear-cut formulated laws, they form habits which inevitably affect and in many cases control them in their family life, and in all of their acts outside of working hours. With almost certainty they begin to guide the rest of their lives according to principles and laws, and to try to insist upon those around them doing the same. Thus the whole family feels the good effect of the good habits which have been forced upon the workman in his daily work through the task idea and all that accompanies it. The task draws a sharp line between success and failure, and the large daily premium which workmen receive when they cross this line, leaves no doubt in their minds as to the difference between the two, and the habit of being successful makes them distinctly more self-respecting and more self-reliant. This is clearly seen in many cases in their more prosperous and cheerful look and carriage, and in their whole address. [Incidentally this is an example of how Taylor made work more pleasurable and interesting.] One of the best results is that they look upon the men composing the management as their best friends, and as helpers with whom to cooperate, instead of spending as formerly, a considerable part of their time in suspicious watchfulness or in practicing deceit, and in the worst cases, in almost open warfare. Harmony in place of discord makes life better worth living.

No man can do two things at the same time, and the actual good that the workmen get from doing useful and interesting work in the time which they formerly spent in discussing their grievances and in trying to devise remedies for them, is no small gain in their lives.

I am spending so much time upon this aspect of the case, because it appears to me that the effect of the system upon the workman is in the end the most important element in the whole problem.

He regarded the reduction of labor costs as *very* important, and he regarded the increasing of wages as *very* important. But it was his deliberate opinion that the *most* important feature of any system must be its effect upon the workman's character; and it is to be remembered that the manuscript in which he recorded this was not prepared for the general public (this was more than a year before the general public ever heard anything about his system), but for an audience at Harvard's Graduate School of Business Administration made up of managers, actual, embryo, and would-be.

It was the same series of lectures in which he spoke of the "lash." These two things must be linked if we would understand him. The lash — but only as it may help to develop character. Without an increase of character — that which expresses itself in self-control, in industry, in application, in willingness to give, in willingness to face and to do that which is disagreeable — wages are likely to be increased only temporarily or nominally. And without the diffusion of character there can be no real democracy. It is not true that power can be transferred from this person to that person at will, or that power can be split up among a set of persons by such things as legislation and strikes. Without character, there can be power only in the sense of power to retard, to check, to destroy. Above everything, character. This, most decidedly, was the Taylor of it.

If there was only a beginning with the "working shoulder to shoulder" principle at Midvale, it was a real beginning. Actuating what Taylor did there we can see, in fact, all four of the principles that in his later years he brought to consciousness and struggled to formulate: first, "the development of a true science," the reducing of all things to law; second, "the scientific selection of the workman"; third, "his scientific education and development," or "bringing the science and the workman together"; fourth, "intimate, friendly coöperation between the management and the men," or "the almost equal division of the work."

That all this did have a real beginning at Midvale is indicated by the fact that there appeared in those works the better moral atmosphere to which Taylor referred in his Harvard lectures and which to this day continues to distinguish the establishments where his principles are practiced "in spirit and in truth." Said Taylor in his paper of 1895:

> A noted French engineer and steel manufacturer, who recently spent several weeks in the works of the Midvale Company in introducing a new branch of manufacture, stated before leaving that the one thing that had impressed him as most unusual and remarkable about the place was the fact that not only the foremen, but the workmen, were expected to and did in the main tell the truth in case of any blunder or carelessness, even when they had to suffer from it themselves.

In commenting on Taylor's paper when it was read before the A. S. M. E., Gantt said:

> His method of fixing rates by elements eliminates, as nearly as possible, all chance of error, and his differential rates go a long way toward harmonizing interests of employer and employee.
>
> It was my good fortune to work for a year as his assistant in this work, and I fully agree with him as to the effect on the men. They improve under it, both in honesty and efficiency, more than I have seen them do elsewhere. Realizing that substantial justice was being done, and that to do their duty was to follow their own interest, it soon became a matter of habit with them.

The sum of it would appear to be this: that it is not enough for management to cease bewailing the lack of character, vision, and ability it may find in its employees, treat them in accordance with a sympathetic sense of their deficiencies, and provide them with immediate rewards for doing well; in addition to this, the management must develop and keep developing itself and meanwhile develop its employees; training them, as it itself acquires these things, in habits of skill and of truth and industry.

From the beginning Taylor followed this course. As he sought to develop himself, so he sought to arouse his men, to give them a vision, and help them to get there. At the start his course pertained more to his personal relations with his men than to his official; it was largely extramanagerial. But gradually he came to incorporate this course as a necessary part of the managerial office itself.

It may not have been pure democracy — in fact, it *could* not have been — but it was the course of those who realize that every man is their brother, and that in the nature of things and if only for their own highest good, they, as they occupy positions of advantage, are for their brother responsible. Hence it represented a movement *towards* democracy, and that, we take it, is the main thing.

CHAPTER XIII

GOOD–BYE TO MIDVALE

ON May 3, 1884, which was the year in which he was made chief engineer, Frederick W. Taylor was married to Miss Louise M. Spooner, whom he had known since childhood; the ceremony being performed in the old Unitarian Church at 10th and Locust Streets by its then venerable pastor, Dr. William H. Furness. Throughout his married life, it was Frederick Taylor's aim not merely to gratify his wife's wishes, but to anticipate them, and not merely to provide her with continued happiness, but to shield her from everything unpleasant. At home he permitted his happy, affectionate, and prankish nature to flow forth without stint. He was there so much in the habit of tossing aside his dignity and playing the amusing urchin that his wife often wondered that people elsewhere seemed to take him so seriously. In her presence all his troubles were dropped.

Going to Midvale when he was twenty-two and leaving there when he was thirty-four, he packed into these twelve years of his young manhood an aggregate of achievement which without exaggeration can be called exceptional. While he was acquiring the expertness at tennis that enabled him to win with Clark the doubles championship of the United States in 1881, he had begun the study at night that qualified him for the degree of M. E. he obtained at Stevens in 1883. From 1878 on to about 1881 he resorted to every method he could think of to force his men to increase their production; then came his time-study, metal-cutting, and belting investigations, and the years of wearing struggle to build up a system and develop an organization that would facilitate the establishment and maintenance of his scientifically-determined standards. In the meantime he met the claims of friendship, won a wife, and established a home of his own. In 1883 and 1884 he designed and superintended the construction of a new machine shop having many novel features. In 1886, two years after his marriage, he joined the A. S. M. E., became an attentive student of its papers, and prepared one of his own (on the use of gas in open-hearth furnaces). As master mechanic and chief engineer he became responsible for all repairs and maintenance throughout the works. And all along he poured out his ingenuity in the invention, not only of management devices, but of purely mechanical; this latter form culminating in the designing, apparently in the latter part of 1889, of his great and revolutionary steam hammer. He never could have accomplished what he did, of course, if he had not had that gift of "making better use of other men than they could make of themselves." But in the main it bespoke that magnificent height of spirit which finds every difficulty superable and every problem soluble.

Throughout these years he was a source of innocent merriment to the other department chiefs and to the minor officials. It was not only that in this he met the fate of every bold innovator; the eagerness, the ardency with which the young man threw himself into his work was without a parallel. He seemed to count that day lost whose low descending sun viewed from his hand no novel action done. Hardly is it strange that even the high officials found there was something *outre* about him; but, somehow, they always felt that "if he was crazy, he ought to have a chance to prove it." Surely they let him take on himself a load of responsibility. It has been said that responsibility never is so much conferred as assumed. It is certain that Taylor seized all he could lay hands upon, and not only seized it but stood up to it, whatever the event. While, as notably the case in his metal-cutting study, he frequently started more than he intended, he had a way of going through with it. Sooner or later, in fact, he bobbed up with results unmistakably tangible and indisputably practical, and withal of such value as more than justified their cost. If in his flaming zeal he now and then burned up money needlessly, it invariably was kept from becoming a conflagration by the cooling stream of his common sense.

Eventually they all had to concede that in the madness of a man who gets two forgings turned where only one had been turned before, there must be a gleam of method, and that it might be a good thing for the works in general to go crazy to this extent. There also was the fact that through his development of standard practice for the care of machinery and belting and his instruction-card and tickler system, he had cut down the repair force of the works about a third. So, apparently along about 1886, Russell W. Davenport, the superintendent, adopted Taylor's general methods for the entire works, and when in 1888, two years after the Harrah régime began, Davenport left Midvale to go to the Bethlehem Steel Company, these methods were continued under his successor, Mr. Petre.

Now, three years before this, or in 1885, there had begun to unwind the chain of circumstances that was to take Taylor himself from Midvale in the fall of 1890, and this was the manner of it:

As work for the army and navy was done at Midvale, officers from those branches of the government were stationed there as inspectors. These officers were in a position to judge impartially as to what went on there, and it would appear that none of them was able to see anything humorous in the part there played by Frederick W. Taylor; the fact being that they became the source of rumors that in his case Midvale had as an employee a young man of romantically-high character combined with energy and ability most extraordinary.[1]

In 1884, when Grover Cleveland was elected President of the United States, he selected for his Secretary of the Navy that skilful politician, keen and energetic man of business, widely-informed man of the world, and charming gentleman, William C. Whitney. What Mr. Whitney proceeded to do to develop the navy as soon as he took office in 1885, is well known. Among other things, he wanted a man of first-rate ability for the superintendency of the navy's great gun-works at Washington, and to find such a man Commander (later Rear Admiral) Caspar F. Goodrich received a roving commission. Made acquainted with Taylor's fame among the government inspectors at Midvale, Goodrich visited those works among other places, had a talk with Taylor, and placed his name at the head of the list he turned in to Whitney. In due time Taylor was invited to Washington, and though Mr. Whitney was unable to interest him in the superintendency of the gun works, he left with that gentleman a lasting impression. Thus when, at the close of the Cleveland administration in 1889, a general manager was needed for an enterprise known as the Manufacturing Investment Company in which Mr. Whitney in the meantime had become interested, his thought again turned to Taylor.

The Manufacturing Investment Company was organized in New York to exploit a patented process for the conversion of wood products into fibre suitable for the making of paper, including such paper as is used for boxes and container-boards.

[1] The government inspectors at Midvale were drawn from the officers of the army's Ordnance Department and of the navy's Bureau of Construction and Repair; and it is highly significant that throughout Taylor's career the men who officered these government departments were, with their engineering education and disinterested professional outlook, practically unanimous not merely in their approval of but enthusiasm for Taylor's leading management principles and methods. We shall see that it was an ordnance officer stationed at Midvale while Taylor was there who was responsible for the first attempt to introduce the Taylor System into the army's manufacturing arsenals.

The special attraction of this process lay in the fact that it was designed to utilize particularly the slabs and edgings produced in the manufacture of lumber, which by-products then were generally burned up as useless. The process was invented by a German chemist named Andrew Mitcherlich. Coming to this country and obtaining patents here, Professor Mitcherlich first interested Don M. Dickinson, of Michigan, a great lumber State. In Cleveland's administration Dickinson served as Postmaster General, and it was through him that Whitney, his fellow Cabinet member, became interested in the Mitcherlich patents. Through Whitney in turn interest in these patents spread to Daniel Lamont, President Cleveland's secretary, and to the brother of Mr. Whitney's wife, Colonel Oliver H. Payne, of New York, a gentleman of great wealth prominently identified with such huge corporations as the Standard Oil Company and the American Tobacco Company. When the Manufacturing Investment Company was organized, with Whitney as president, all these gentlemen subscribed to the company's capital stock.

Early in the Cleveland administration, the practicability of the Mitcherlich process was proved to the satisfaction of Whitney and his associates at a mill started at Alpena, Michigan, by the Fletcher Paper Company. And before the Cleveland administration closed, the Manufacturing Investment Company had established two mills, one at Madison, Maine, and the other at Appleton, Wisconsin. The Madison mill was placed in charge of Commander Goodrich, and the Appleton mill in charge of Commander (later Rear Admiral) Robley D. Evans, familiarly and widely known as "Fighting Bob." To take up this work these officers received leave of absence from the Navy Department.

When in the spring of 1890, then, Whitney made Taylor a definite offer to become the general manager of the Manufacturing Investment Company, this company had become fairly well established. The offer was that of a three-year contract, and included an agreement that Taylor should have the privilege of subscribing for shares of the company's stock at par and that upon these shares a dividend would be guaranteed. The net of the offer was to insure him a financial return much larger than he received at Midvale and one that, in those days, was exceptionally large for a young man of thirty-four. Apart from this, the prospect was attractive since the chief men behind the company were of national reputation and influence, and all had firm faith in the company's future. It was expected that the mills established in Maine and Wisconsin would be the forerunners of a big chain. For some time, however, Taylor hesitated. In fact, he wanted his old friend, Wilfred Lewis, to have the position, and urged upon him that he was better qualified for it. To this Lewis positively refused to assent, and it was after it was in turn urged upon Taylor that he could not in justice to himself refuse Mr. Whitney's offer that he yielded. His formal resignation of his position at Midvale was sent in on May 28, 1890, and it was agreed between him and the president, that great joker, Charles J. Harrah, the younger, that it was to take effect the following October.

In his later years it became one of the favorite "arguments" of Taylor's opponents that wherever his methods were introduced they proved to be a failure and had to be thrown out. This sort of argument evidently was started seven years after Taylor left Midvale, or in 1897, when he was reorganizing the works of the Simonds Rolling Machine Company in Fitchburg, Massachusetts. So disturbed was Walter A. Simonds, the head of this business, by the reports then circulated that, on October 20, 1897, he wrote to the Midvale Steel Company about them. Thus, under date of October 22, Mr. Harrah addressed this short but interesting letter to Mr. Taylor:

My dear Taylor: —

For God's sake don't bring your Uncle William Sellers, or should I say, Walter A. Simonds into any controversy with me. I have got lots of this kind of stuff to attend to myself. For God's sake give him a job, give him a dividend, buy something for him; do anything under heaven, but don't let him write me letters.

You see, Mr. Harrah had to have his little joke. But having had it, he on the same day — probably the two letters went off in the same mail — wrote to Mr. Simonds as follows:

Walter A. Simonds, Esq.

Hotel Bellevue, Boston, Mass.

Oct. 22, 1897.

Dear Sir: —

We are in receipt of your favor of the 20th inst.

Mr. Taylor was on the staff of this Company from some time in 1879 until the fall of 1890; during the latter portion of which period he was the Company's Engineer.

In reply I would answer: —

(1) Mr. Taylor did have full authority to introduce his methods.

(2) There are now in use at these works to a greater extent than they were at the time Mr. Taylor first introduced them, because the Works are much larger than they were when Mr. Taylor was in the employ of the Company.

(3) If Mr. Taylor's methods were not considered advantageous they would have been thrown out long ago by Mr. Harrah, President, or by Mr. Petre, Superintendent, neither of whom is actuated by any sentiment in the management of the Company.

We take advantage of this opportunity to place on record our high regard for Mr. Taylor, both in his private capacity, as an honorable gentleman and a hard working man — and in his professional capacity, as one of the leading Engineers of the country today.

Mr. Taylor has left at Midvale in our Forging Department a hammer which will be a monument to his ability as a mechanic, as well as to his scientific attainments long after Mr. Taylor will have passed away.

Any further information that you may ask of us we shall be most happy to give you.

We are,

Yours most obediently,
THE MIDVALE STEEL CO.,
Per Chas. J. Harrah, President.

When Taylor received the letter Harrah addressed to him, he wrote in reply a full explanation of the trouble he was having in Fitchburg. To this Harrah responded:

It was quite unnecessary; I understood the situation fully; I think you and I know one another sufficiently well to know who we are and what we are at. Don't let those fellows bother you. The best evidence of your success is the hostility which you have inspired and the criticisms to which you have been subjected. I have known people to speak ill even of *me* and of *John Wanamaker*.

Though Midvale did not throw out Taylor's methods, it began, not long after he left there, to slough them off. Not deliberately or consciously. Seven years after Taylor's departure, Harrah could write with entire sincerity that they were continuing to practice those methods; he honestly thought they were — and no doubt they really were, to a certain extent. No place that once has felt the real Taylor touch is likely to lose it wholly. At Midvale, for example, they continued to act on the Taylor principle that men cannot be induced to do an extra-ordinary day's work for an ordinary day's pay. Beneath the cynicism Charles J. Harrah affected was considerable kindliness. "Be careful of the men," he used to enjoin on his officers; "machines can be replaced, men not." He was kindly enough and enlightened enough to let his mechanics go on drawing $3.50 or more a day when in establishments all around Midvale mechanics of the same grade were permitted to earn not more than $2.50. And they attempted to continue the practice of scientific rate-setting. But as the years went by, the rate-setting fell into the hands of men more and more inclined to return to the old way of guessing.

For this sloughing or sagging, there is a ready explanation: no one at Midvale except Taylor himself was imbued with the philosophy that lay back of his methods and mechanisms. In his later years Taylor came to see clearly that Scientific Management could not exist in any establishment until chief executives, planners, supervisors, and executors or operatives all had undergone the "complete mental revolution" involved in "recognizing as essential the substitution of exact scientific investigation and knowledge for the old individual judgment or opinion in all matters relating to the work done in the establishment." He saw that unless this new state of mind, this new outlook, generally prevailed, his methods and mechanisms could not go on serving the purpose for which they were designed; that they would remain undeveloped and would be practiced or operated only half-heartedly, and were likely soon to be cast off wholly or in part. And so he and his followers came to recognize that the thing of prime importance was the inculcation, the persistent teaching, of the philosophy. But in his Midvale days he himself scarcely was conscious of it, practicing it almost wholly from instinct.

It is so easy to guess, and so troublesome to find out; and it is to be observed that Midvale, highly profitable though Taylor's methods were to it for many a year, went right on making money as it sloughed those methods off. There is, you see, no invariable relation between scientific economy of manufacture and the success of a business, as its success is reckoned in terms of money-making. The profits of a business depend upon the margin between its costs and its selling prices; and if the prices can be made high, the costs, of course, need not be low. And prices can be made high or held up where there is protection afforded by patents, combination, location, marked superiority of designing or of financial strength and ability, or some other element of monopoly or semi-monopoly. And even where there is free or active competition, a business, to make money, need not be any more efficient than its competitors. The public may suffer from the lack of economy, but not necessarily the business.[1]

This means that until scientific economy becomes the rule, not the exception, the chances are that an outreach for it must be motivated by some consideration larger than that of mere money-making. As so strikingly illustrated in Taylor's case, there must enter into it some prompting of a *social* instinct, some desire to be of service to the public or to one's own employees, or something of the professional man's pride in performance.[2]

Just as it was the idealist in Taylor that embarked him on and held him to his course, it hardly was to be expected that anyone would attempt to follow in his footsteps who was not something of an idealist also. And when we consider that bound up in his ideal was the principle of reducing all procedure to a reign of law equally binding on management and men, it will be realized that, leaving the present out of account, it was by far too high an ideal for the vast majority

[1] Of these things none was better aware than Taylor; the fact being that our foregoing paragraph is largely a paraphrase of what he wrote on this subject in *Shop Management* (p. 19).

[2] The chances are that in the future scientific economy in this country will be more and more enforced upon management by the money-making motive alone. To quote from Dr. H. S. Person's fine article on "Shaping Your Management to Meet Developing Industrial Conditions," the industrial history of the United States has, in its broad outlines and prevailing tendency up to this time, exhibited all the phenomena of a sellers' market, this because "we have been pioneers — explorers, appropriators and exploiters of a vast continent of extraordinary resources," and our population in consequence has had a "geometrically increasing purchasing power." This appropriating and exploiting period must pass, and as it passes, a buyers' market will succeed the sellers'. "On a sellers' market," says Dr. Person, "selling is but order-taking; on a buyers' market it must be real merchandising. On a sellers' market production is but the hasty and wasteful process of giving material things a form or other quality which will satisfy insatiable and not over-critical demand; on a buyers' market it must be more precise and economical."

of the managers of his day. Was he foolish, then, in the years that followed his departure from Midvale, to spend his strength trying to get his ideal realized? We think not. Thereby it was brought directly to his own consciousness just what his ideal meant, and thereby he received daily instruction in what was necessary to its realization under divers conditions and circumstances. And there also are those important considerations embodied in the quotation from Herbert Spencer with which, as appropriate to the general period covered by it, we begin our next book.

BOOK IV

THE CONSULTING ENGINEER IN MANAGEMENT

Whoever hesitates to utter that which he thinks the highest truth, lest it should be too much in advance of his time, may reassure himself by looking at his acts from an impersonal point of view. Let him remember that opinion is the agency through which character adapts external arrangements to itself, and that his opinion rightly forms part of this agency — is a unit of force constituting, with other such units, the general power which works out social changes; and he will perceive that he may properly give utterance to his innermost conviction: leaving it to produce what effect it may. It is not for nothing that he has in him these sympathies with some principles and repugnance to others. He, with all his capacities, and aspirations, and beliefs, is not an accident but a product of the time. While he is a descendant of the past he is a parent of the future; and his thoughts are as children born to him, which he may not carelessly let die. Like every other man he may properly consider himself as one of the myriad agencies through whom works the Unknown Cause; and when the Unknown Cause produces in him a certain belief, he is thereby authorized to profess and act out that belief. . . . Not as adventitious therefore will the wise man regard the faith which is in him. The highest truth he sees he will fearlessly utter; knowing that, let what may come of it, he is thus playing his right part in the world — knowing that if he can effect the change he aims at — well; if not — well also; though not *so* well.

Herbert Spencer's *First Principles*

CHAPTER I

THE GENIUS OF TAYLOR'S SYSTEM

HE served as the general manager of the Manufacturing Investment Company for three years (1890 to 1893). This experience led him to see the need of a new profession, that of the consulting engineer in management, as it is nowadays called. He practiced this profession for eight years (1893 to 1901), and in doing so was brought in contact with companies representing a variety of manufacturing problems. In all it furnished him with the experience he needed to bring about the refinement and coördination of methods and mechanisms marking his system in its highest development.

It is true that throughout this period, except towards its close, he continued to think of his work mainly in terms of an improved piece-rate system, and as he worked out various minor systems which later were incorporated into his general system, was conscious of aiming only at "good management." In the midst of his intense practical activities, he hardly could reflect on the principles actuating his course. Nevertheless, the principles were there, and however unconscious he was of it, were directing his activities to a certain general end. Hence, if we would follow his activities in this period intelligently, we must not only have some advance knowledge of their general nature and of the part they ultimately played in his scheme as a whole, but also have a clear understanding of that which was the ruling or predominant spirit of the whole, or that, in fine, which was its *genius*.

What we have seen thus far may be summarized as follows: For weighty reasons largely pertaining to the wage problem and the general contentment of his men, but all, at the last analysis, pertaining to the economy of manufacture, he determined to set for his men definite tasks, thereby establishing for them high standards of accomplishment. To do this he had to standardize their methods. Also he had to standardize all those shop conditions upon which standards of accomplishment depend. At the same time he had to look to the maintenance of his standards. Involved in all this was system-building and organization-building of the most intensive kind: the devising or selecting of standard managerial methods and mechanisms for controlling all the methods and conditions of work; the centralization of this control in a department; a new definiteness of function and of responsibility; the assignment along correct psychological lines of clean-cut tasks to planners and executives as well as to executors; the high training of personnel in industry, skill, and democratic coöperation.

The fundamental part played in his system by the principle of standardization may be read even by him who runs. But the reading will be in vain unless it is understood that, with Taylor, standardization had a definite and therefore limited meaning. *The Century Dictionary* defines a standard as, among other things, "a criterion established by custom, public opinion, or general consent." With Taylor, however, a standard was a criterion or model established *as a result of scientific investigation.* In this change of phrase — a very simple one as it appears on paper — we have the thing that gave to Taylor's work in industry its marked distinction, and that which distinguishes it particularly from the work of the host of "efficiency engineers."

The introduction of new methods into industry, or even the patching up of existing systems, with the object of bringing about a higher efficiency, is honest work — when it is honestly done. But in work of this kind Taylor had little interest. In industry there is as much need of the right kind of opportunists as elsewhere. But in industry Taylor was not an opportunist of any kind. He was a revolutionist in the sense that what he aimed at was not merely a higher efficiency, but the highest.

To aim at a higher efficiency, you have only to set up a higher standard than already exists — something that usually can be done easily and quickly. But when you aim at the highest, you mean the highest that knowledge makes possible; and so you have to defer setting up your standard until you have found out, not only what that knowledge is, but what it can be made to become. True, *some* investigating must be done even when the object simply is to improve on existing conditions. Strictly speaking, however, science is not merely the spirit of inquiry; it is the spirit of truth and the *whole* truth. It seeks not merely the facts, but *all* the facts. And between merely looking into things to make them better and the investigating that has for its object the discovery of the one best way, there is, in actual practice, a difference in degree so vast as to amount to a catastrophic difference in kind.

A standard, again, has been defined as a "form, type, example, instance, or combination of conditions accepted as correct and perfect." In Taylor's philosophy, however, the acceptance was for *the time being*, or as the form or type represented the best known in the existing stage of the development of the art; and when this is grasped, with all its implications, it will be clear that his standardization principle, instead of blocking progress and discouraging men from using their inventive powers, is essential to continuity of progress, and is what is needed to compel men to use their inventive powers to real account.

In an address he delivered less than three weeks before his death,[1] he said:

[1] At Cleveland Advertising Club, March 3, 1915.

Scientific management at every step has been an evolution, not a theory. In all cases the practice has preceded the theory, not succeeded it. In every case one measure after another has been tried out until the proper remedy has been found. Every new element has had to fight its way against the elements that preceded it, and prove itself better. All the men that I know of who are connected with scientific management are ready to abandon any scheme, any theory, in favor of anything else that can be found that is better. There is nothing in scientific management that is fixed.

He did not figure that scientific management ever could be omniscient management. He conceived that it must needs be, by its very nature, a constant invitation to innovation. He provided for progress when, in defining the functions of management, he said that "one man should be especially charged with the work of improvement in the system and in the running of the plant." [1]

If anything, he went to an extreme in his recognition of the mutability of the methods and mechanisms that went to make up his system. Nevertheless, his position was that until better were discovered, these were to be accepted and used. Why resort to expert investigation to discover things if these things are not to be utilized? And manifestly there can be no system, no order, unless standards are protected from change for the sake of change. It was his wisdom that a desire to improve things may degenerate into a fussy tinkering which, as it keeps you from seeing where improvement really or mostly is needed, blocks progress as effectually as a belief that all things must remain as they are; and it was this he had in mind when in his later years he picturesquely protested against "damned improvements."

Unless standarization follows the discovery of best ways, those practicing the art will be left to rediscover those things over and over again. Invention means progress only when

[1] *Shop Management*, p. 120.

based on the best already known. We have seen how steadfastly in his own practice Taylor followed this latter principle. In investigating what others had done, his search was directed particularly to discovering the things that had proved most successful in practice. Hence his course in building up his system represented in *all* its particulars that continuity of progress which is evolution. "The rapid and successful application of the general principles involved in any system," he wrote, "will depend largely upon the adoption of those details which have been found in actual service to be the most useful." [1]

His search showed that the "finest developments" were "for the most part isolated" and "in many cases almost buried with the mass of rubbish" surrounding them,[2] and he rendered a high service if only by what he did in bringing these finest developments together. It will appear from this that he standardized the work of others as well as his own. In acknowledging his indebtedness to others he was extremely generous, especially in view of the fact that whatever he borrowed he practically always developed or in some way improved.

It was because he was a practical man that he built a system. Men who favored scientific management in a general way, or were just in favor of efficiency or of progress in general, presented to him a spectacle of pathetic futility. At the same time, he was no system monger. He realized that as his system is applied to different establishments it must be adapted to the particular manufacturing problem as this problem is revealed by scientific analysis; that every application, in fact, must represent a *specific* development along the lines he had followed in developing the general scheme. Naturally his system attained its maximum complexity as applied to es-

[1] *Shop Management*, p. 202.
[2] *Ibid.*, p. 201.

tablishments manufacturing miscellaneous machinery; for there the manufacturing *problem* attained its maximum complexity. Presumably his judgment as to the amount of system needed in particular cases was not infallible, but system for its own sake was abhorrent to his economic instincts.

A highly flexible system, and yet made up of definite methods and mechanisms, the whole being bound together by the mutual attraction of the several parts. It was an immense act of constructive imagination, not unlike that of the poet's. For the scientific spirit in industrial management had largely been an airy nothing. Such embodiment as it had found had been partial and fleeting. It was Taylor who really gave it a local habitation and a name.

Just as he strove to intellectualize himself — that is, manage his whole life according to reason, right arrangement, and systematic regulation — so he strove to intellectualize industrial management. In each case the central idea was the same — *control!* First we see the intellect using its powers of analysis, abstraction, and comparison for the setting up of definite standards. No sooner is this done than all things seem to conspire to break down the standards. And in one's power to resist this conspiracy lies one's control.

So the genius of the system that Taylor built may be summed up in this: that from a centre corresponding to the brain of an animal organism, it provides for the intensive control, "according to clearly-defined scientific rules and formulae," of all the methods, implements, materials, and general conditions of work, and in consequence the volume, flow, and quality of work.

As specially illustrative of his striving to intellectualize his work, and particularly of the part played by the central idea of control, let us now give attention to two particular phases of the development of his system in this period — mnemonic classification and cost accounting.

CHAPTER II

ANALYSIS AND CLASSIFICATION AS A BASIS FOR CONTROL

BECAUSE the intellect has the powers of analysis, abstraction, and comparison, it has endless power to synthesize, or construct new combinations, and to classify, or group things according to their likeness or agreement and give them *symbols* or *names.*

The analysis is the big thing.

> Mr. Taylor was a philosopher [writes Henry P. Kendall [1]], and there are two or three bits of his philosophy which have had a great influence on me. I think that perhaps the biggest one of these ideas had to do with the relative importance of analysis. Mr. Taylor once said that Scientific Management was 75 per cent analysis and 25 per cent common sense. I believe that is somewhere near correct. Prior to that time, I had considered analysis as a relatively small factor, and the constructive work the larger. Now I see that in both manufacturing and sales, as well as finance, analysis is the most difficult and the most important. When the analysis of a proposition is thoroughly made, the constructive work is reasonably simple.

It is the way, of course, that every form of knowledge is scientifically organized: first the analysis, or reduction of the problem or subject to its elements; then the synthesis, or the regrouping of these elements in accordance with some principle of significant or essential likeness. Usually there will be broad general divisions (generic classes); each division having

[1] Now interested in the ownership and management of various large corporations, Mr. Kendall was formerly general manager of the Plimpton Press of Norwood, Massachusetts, and as such was the first to apply the Taylor System to a large printing and binding plant throughout.

subdivisions, each subdivision sections, and so on. And as your classification is for use, you must have some system of *naming* or designating your divisions, subdivisions, sections, and subsections, so that each element or detail can be readily identified.

Every name is a symbol, or a sign representing with comparative brevity an object with all its characteristics. It is primarily for the sake of brevity that practically all symbols exist. If when you referred to a tree you had to designate it as "a perennial plant which grows from the ground with a single permanent woody self-supporting trunk or stem," it is easy to see how this would hamper conversation and especially writing. Symbols, in fine, constitute a shorthand language. Without their convenience, no form of knowledge could be developed.

However, though every name really is a symbol, what we have come ordinarily to mean by symbolization is the extension of the shorthand principle to names themselves, and this chiefly by means of letters, as when a chemist uses H_2SO_4 to save himself the time and trouble of writing "two parts of hydrogen, one part of sulphur, and four parts of oxygen."

The need of a special system of nomenclature or symbolization was introduced into industry by the increasing complexity of machinery; as machines became composed of more and more parts, the more need there was of a specific name for each part.

In 1881, Oberlin Smith, destined to become a warm personal friend of Taylor, read at the second regular meeting of the A. S. M. E. a paper entitled "Nomenclature of Machine Details," in which he described the system of symbols devised by him for the company of which he was president.[1]

The requisites [said Smith] for a good system of names and symbols are: (1) *Isolation* of each from all others that did, do, or may exist

[1] The Ferracute Machine Company, of Bridgeton, New Jersey.

in the same establishment. (2) *Suggestiveness* of what machine, what part of it, and if possible, the use of said part — conforming, of course, to established conventional names, as far as practicable. (3) *Brevity*, combined with simplicity.

What Smith called suggestiveness in a symbol is, of course, the quality commonly called mnemonic, or that which enables a symbol to be easily remembered.

Now, as Taylor began at Midvale to split up labor operations into their elements and time them, he was confronted by the need of recording, classifying, and indexing these elements, so that each could be quickly found. He called this work the most difficult part of time study, and as a matter of fact his first two years of time study was so poorly classified and indexed that he threw it all away. As he made the care, storing, and issuing of tools a function of management, he was confronted by another problem in classifying, symbolizing, and indexing; and so it continued as he analyzed other features of management, tangible and intangible: the storing of materials; the routing of work; the maintenance of the plant; all of the things pertaining to sales, accounting, and the keeping of costs; the tabulating and filing of data of all kinds, including standing orders relating to the duties of the organization's subdivisions and of the individuals therein included.

In fact, as he was confronted by the need of coördinating all of the divisions of management, he was confronted by the need of a system of classification and symbolization *that would comprehend the whole scope of industrial activity.*

By utilizing the labors of such thinkers as Oberlin Smith and Henry R. Towne,[1] and by drawing on the assistance of his own associates, especially Carl G. Barth, Taylor, out of a combination of letters and numbers predominantly mnemonic,

[1] Mr. Towne had devised for the Yale & Towne Manufacturing Company a system of symbols for shop accounts.

eventually did work out such a system — at all events to an extent that served the needs of his time and indicated the lines of further development.[1]

As an example of his system, and incidentally of the complexity attained by machine-tools, let us take a symbol that might be used by a company manufacturing such machinery and needing to designate specifically each part of every machine it produces — such a symbol as M 20–72 L C 1 C. Here M designates the broad generic class represented by Metal-Working Machine Tools; L, the subdivision represented by Lathes; the figures 20–72 before the L, a 20-inch lathe with a 72-inch bed; the first C, the Carriage group of parts belonging to this Lathe; the second C, the Cross-Slide division of the Carriage group of parts; and the number 1 before the second C, the first piece in the Cross-Slide division. It will be seen that the value of each particular letter and number depends upon its position in the symbol as a whole.

While the construction of a machine symbol like the foregoing presents its own problems in analysis and classification, these problems derive a relative simplicity from the fact that all the objects dealt with are tangible and highly visible. Naturally it is different with such intangible things as management functions and labor operations.

The analysis of a subject, of course, may be for the purpose of organizing (i.e., reducing to order) the knowledge concerning it purely for the sake of the knowledge, or for the purpose of organizing the knowledge for practical use. When this latter is the case, as it always must be in industry, the analysis inevitably suggests constructive work in the sense of improvement; if you have enough mentality to reduce a thing to its elements, you surely will be led to review these elements

[1] It would appear that all the industrial systems of classification and symbolization, including Taylor's, owe much to the Dewey decimal system, well known from its use in public libraries.

to see if they cannot be improved individually, or an improved combination formed. Hence Taylor's saying that analysis is three-quarters of Scientific Management. This is illustrated by his job analysis — as he listed the motions made by his men, he could not well have failed to observe them *critically*. It means that the very process of detail analysis and classification tends to standardization. "You do not want to classify things and put them down in permanent records until you are satisfied that they are the best known for the purpose."

The very act of recording also has a broad significance, as was brought out in a paper read in 1915 before the Taylor Society by John H. Williams, a consulting engineer:

> It is generally recognized that, throughout the period of recorded history, man's intellect has not been materially augmented, and that the progress of later generations is due largely to accumulated knowledge, and not much to superior intelligence. It follows that progress is dependent upon man's ability to record existing methods, since there can otherwise be no accumulation of knowledge except through word of mouth. . . .
>
> The first essential in recording anything is an adequate means of designation. Until the advent of Frederick W. Taylor, the functions and the things involved in industry were thought to be innumerable, and for that reason were considered impossible of designation. But just as in architecture the mechanical drawings and plans are completed before any of the physical work begins, and are then followed out to the letter, so, since Mr. Taylor's application of the principles of science to management, and the consequent perfecting of the mnemonic index, it is now increasingly customary to make indexes and instructions for management, and to have them carried out to the letter as minutely and as literally as architectural and mechanical plans are carried out.
>
> The function of the Index and Instructions in management, the accuracy and facility with which instructions may be written to symbol, and the analogy of these indexes and instructions in man-

agement to assembled, detail, and working drawings in construction, are fundamentals, the comprehension of which gives some conception of Mr. Taylor's vision, which, though popularized, is as yet only superficially and inadequately understood.

In view of the fact that really to know a thing you must analyze it, and that it is through classification and symbolization that the knowledge so gained is reduced to order and made available, we see that as Taylor, on behalf of an industrial organization, resorted to analysis, classification, and symbolization, in connection not only with its particular activities, but also with it as a whole, he was obeying for that organization the stern precept of the Delphic oracle, *know thyself*. For an organization, as for an individual, it is absolutely fundamental. But to what end? The answer to this can be read in what Taylor had to say in his Harvard lectures about his classification and symbolization of tools:

Every trade has, through the evolution of years, developed an enormous number and variety of small hand implements, such as files, chisels, hammers, wrenches, cutting tools and abrading tools, of all kinds; so that in the course of every day in a machine shop, for example, each workman will use perhaps fifty to a hundred different hand tools in his regular work.

During the past thirty years, a scientific study of the proper shape for each of these implements has been made, and, as you will appreciate, the ultimate value of each of these implements has hinged principally upon the speed and accuracy with which it is capable of doing its work. Thus the most minute study has been made of the effect which changes of form and of the quality of the materials in these implements have upon their speed. And this time study of these implements has made it possible to scientifically select, from among the great number of tools in use, the particular tool which will do its work in the shortest time and produce the best kind of finish.

In a scientifically-run modern machine shop, then, all of these implements have been standardized, and are maintained in a Tool Department in perfect order at all times, thus entirely doing away with the old-fashioned judgment of each workman as to what kind of a tool he liked best, and also doing away with his individual making and care of his tools. With thousands of tools, all of standard shapes, and which must be used in quantities every day by the working men, a shorthand system of naming and identifying these tools becomes an absolute necessity. As long as each workman had his own tools and himself supervised their making, their shapes, and their maintenance, no scientific classification of tools was imperative; but when the treating of tools and their shapes becomes a science, then a nomenclature and a shorthand system of identification, similar to that for identifying machine parts, becomes a necessity.

The case is somewhat analogous to the naming and identifying of the various plants and trees in botany, and the various minerals and rocks in geology. Without a logical scientific nomenclature there would be chaos in the small tool department, and it would be impossible to deliver to each workman, each day, the tools he should have. The intricacy of this tool problem will be appreciated when you realize that there are constantly in a shop, employing say a thousand men, from twenty to fifty thousand tools in the hands of the workmen, and that these must all not only be accounted for but inspected, sharpened, kept in perfect order, and automatically (almost) issued from and returned to the Tool Department.

That is to say, Taylor, as manager, had to know the tools used in the shop, know them in detail, and organize the knowledge concerning them, in order that he might *control* them. And, whether it be consciously held or not, is not that the grand aim of all knowledge, of all intellection — namely, control?

Previously in his manuscript Taylor had specified other things which management must study with a view to their control: "the movement from place to place of the parts of the machine to be built"; "the qualities, strength, and cutting properties of materials from which these parts are to be made"; "the speed and quality of all the movements and acts of all the workmen employed"; "the speeds and feeds, etc., of the various machine tools. In addition," he continued, "we must not forget the various stores and supplies — coal, waste, oil, grinding materials, etc., as well as the purchase and delivery of the raw materials from which the machine parts are made.

"To recapitulate: the problem which faces modern scientific management is the daily control and the direction of what at first appears to be an almost uncontrollable multitude of movements of men, of machines, of small implements, of materials, and of parts in process." There was the central idea — *control*. But control in what sense? "The gist of the matter is," wrote Taylor, "that scientific management[1] demands that the acts of the men and movements of all these men and elements shall be regulated according to clearly defined scientific rules and formulae; and all of these acts and movements must be planned at least one day in advance by the managers."

We have seen that Taylor's study of the "speed and quality of the movements and acts of all the workmen" led to the modern profession of time and motion study, and that out of his study of the "speeds and feeds, etc., of various machine tools" came all of his revolutionary work in the metal-cutting field. What needs some consideration here is the "movement from place to place of the parts of the machine to be built," or what is ordinarily called routing; this if only to illustrate the service rendered by him in adopting the "finest development" of other men, adding them to elements original with himself, and finally so coördinating them as to form a logical and coherent or organic whole.

[1] In Taylor's manuscript it originally was written "task management"; the word "task" being later crossed out and "scientific" substituted. The reason was that, in 1909, when this manuscript was prepared, Taylor still was at a loss to know what to call his system. For years he had been using the term scientific in connection with his methods quite casually, but it was not until the rate-hearings of 1910 that the term scientific management was formally used by anyone.

Many people appear able to conceive of routing only as the physical layout of plants, or the arrangement of machines, work-places, or departments in such order that the flow of work from one to another will be as much as possible progressive or straightforward in space. Obviously this applies mostly to plants where the same articles are made over and over, and the flow of work thus can be controlled by a standardized plan, the simplicity of control being directly in accordance with the repetitiveness of the processing.

As the work done is miscellaneous, its routing becomes variable and complicated, and this especially as the products themselves are complicated or composed of many different parts. For each new job there must be devised a plan for assigning each portion of the work to the machines or workmen best fitted to deal with it, and for keeping the work as a whole flowing straightforwardly *in time.* Here the standardization cannot be in the routing plan, but in the method of devising the plan.

Involved in this is an elaborate analysis of the work (from drawings, specifications, or samples) to determine whether the parts are to be manufactured specially for the order or drawn from manufactured or purchased stores; to determine the relations of the parts to one another so that they may be assembled as required in the process of manufacturing the product; to determine the kind and quantity of materials needed and whether they are to be manufactured or purchased or drawn from stores; to determine the operations which must be performed, their sequence, and so on and so forth.

All this study naturally must be embodied in charts or diagrams and in written instructions to the operatives; and the work of preparing these charts and instructions would be laborious indeed without a system of classification and symbolization by which all such things as manufacturing orders, operations, materials, parts in process, machines, and stores can be briefly but unmistakably designated.

To Oberlin Smith, Taylor was indebted not only for ideas in working up symbols, but also for the basis of his routing system. He again paid tribute to the "remarkable system for analyzing all of the work upon new machines as the drawings arrived from the drafting-room and of directing the movement and grouping of the various parts as they progressed through the shop, which was developed and used for several years by Mr. William H. Thorne, of William Sellers & Co.," but added: "Unfortunately the full benefit of this method was never realized owing to the lack of the other functional elements which should have accompanied it."[1]

As an example of what Taylor meant by this latter statement, we may show how, in his general system, his routing system was supported by his system of apportioning stores.

Soon after he left Midvale, he developed the basis of his now famous balance of stores or running-inventory sheets; these showing for each article carried in stock the quantity on hand; the quantity on order, but not received; the quantity apportioned to orders for shipment or manufacture but not yet issued; and the quantity available for future requirements. As he developed his planning department, he made the keeping of these sheets a special function. Says Horace K. Hathaway:

> The unique features of this element of the System are: keeping the stores balance sheets in the Planning Department instead of the store room, and the apportionment in advance and subtracting the quantity apportioned from the quantity available, issuing as a result orders for the replenishment of stock when the quantity thus shown to be available for future orders falls to the established minimum, instead of when the quantity actually in stock is drawn down to a minimum without regard to the requirements for other orders under

[1] *Shop Management*, p. 201

way in the shop which do not happen to have been called for, but which may be called for at any minute. As a preventive against awkward and costly delays, the value of apportionment in advance will be obvious to the reader.[1]

It has been said that Taylor resorted to classification in connection not only with the particular activities of an organization, but with the organization as a whole. This means that he came to apply his principle of analysis to defining the organization's general plan; thereby indicating "the function, the scope and limitations of the activities of each department and sub-division thereof and their interrelations and responsibilities." From the viewpoint of logic, this is the very first step in systemizing and organizing; but as Taylor began with no theory, and for years had no purpose other than that of finding practical solutions for the practical problems he encountered in his every-day work, it was inevitable that he should begin with particular activities and gradually work up to the general; though, of course, his work in connection with the particular activities would have been without value if he had not had all the time a more or less adequate conception of their relation to the whole.

Now, as Taylor aimed at a comprehensive analysis and classification, or at reducing to order and identifying every detail of organization and of labor as well as every implement and every bit of material, he naturally had to deal with expenses and with accounting in general. Says Henry P. Kendall:

> The accounting in a business includes not only the ordinary bookkeeping, but the entire clerical system which has to do with orders, records and costs. Accounting is the only means by which the management is informed from time to time of the condition of the busi-

[1] "The Planning Department" reprinted in *Scientific Management*, edited by C. B. Thompson, Harvard University Press.

ness, the progress it is making, its weak and strong points, its selling values and costs, and the efficiency of all its departments.[1]

When accounting is thus understood, it is clear that it is inseparable from the means by which an organization gains complete self-consciousness and self-knowledge. It may be called, in fact, a process of self-examination for the purpose of checking up progress and results.

Of all the features of Taylor's work, this one of accounting is the least known. He himself never tried to elucidate it for the generality, and apparently the magnitude of the subject has deterred others from attempting to describe it in any detail. Here, however, we have one of the most important features of his work — and one of the most interesting.

[1] From Mr. Kendall's notable address on "Unsystematized, Systematized, and Scientific Management," delivered in 1911 at the Amos Tuck School at Dartmouth College; published in the Tuck School's *Scientific Management*, and reprinted in C. B. Thompson's *Scientific Management*.

CHAPTER III

ACCOUNTING MADE CONTRIBUTORY TO CONTROL

THAT he was a pioneer in the development of modern industrial accounting appears from the fact that in the early 1890's, when he systematically took up this study, the practice of accounting in industry almost universally consisted simply of preparing, after the annual inventory of stock, statements designed to show the profit and loss of the business as a whole, together with its assets and liabilities.

A curious phase of it is that personally he hated all clerical work and particularly commercial figuring. He once remarked to a friend that if anyone had told him in his youth that he would have to learn bookkeeping, the thought almost would have been enough to drive him to suicide. For all that he was compelled to recognize the existence of square pegs and round holes, he never was entirely cured of his belief that success in any field is not so much a matter of special qualifications as of the *will to get there,* and apparently he found support for this belief in his own achievements. At the same time, it is to be recognized that his ability to work out accounting principles and apply them to the upbuilding of a system was strictly a manifestation of his general engineering ability.

Papers left by him show that even while he was at Midvale he had definite ideas about works accounting. When he became the general manager of the Manufacturing Investment Company, he was forced by the requirements of this position to give heed to the details of accounting. Three years later, when he became a consulting engineer, he apparently foresaw that unless he had an impartial critic of the efficiency of his methods in the form of a proper cost-keeping system, he would be at a disadvantage in dealing with the opposition that his experience had taught him would be sure to arise wherever he tried to introduce his methods. Thus his approach to the scientific study of accounting was mainly from the particular angle of cost accounting. And to say that when he turned his attention to this subject there was no general recognition of the importance of accurately determining, on a basis of ascertained and recorded fact, the group and unit costs of products is to put it mildly — how mildly will be appreciated when it is pointed out that as late as the year 1921 the Federal Trade Commission reported that about ninety per cent of industrial and commercial firms did not know what their costs were.

A proper cost-keeping system of course must have behind it a proper general accounting system, and especially a just and logical method of distributing overhead or indirect expenses. Here, again, before trying to do any original thinking, Taylor strove to get in touch with and to master what at the time was the best thought and practice. In this he had the assistance of a professional accountant named William D. Basley, who had been employed by the Manufacturing Investment Company. Apparently Basley was what nowadays would be called a public or consulting accountant, and as such had had experience with railroads. It is certain that when, in 1898, Taylor introduced his "method of bookkeeping" at the Bethlehem Steel Company, which was the last of the firms to employ him as a consultant, he referred to it as "in general the modern railroad system of accounting adapted and modified to suit the manufacturing business." Undoubtedly railroad accounting developed much earlier than industrial. This was due to the fact that definite standards of accounting were forced upon the railroads soon after they came under the jurisdiction of the Interstate Commerce Commission in 1887; these standards having been worked out by a commission headed by Professor H. C. Adams, of the University of Michigan.

The system Taylor introduced at Bethlehem shows that in the 1890's he not only had developed a comprehensive method of analyzing and classifying expenses and of distributing the overhead on to the products, but also had grasped such principles as written orders for all procedure and of internal check for reducing the possibility of errors and thefts. More important still, his system called for *monthly* reports, and reports presented in such a way as not only to be readily intelligible to the company's officers, but also to lead them to realize the significance of the figures. In fact, the leading feature of Taylor's general accounting system would appear to be the unerring certainty with which it enables the manager to pick out the cause of any unusual cost or waste; this being another manifestation of Taylor's exception principle.

In large measure these principles are now the commonplaces of all well-systemized businesses. To what extent their somewhat general practice is due to Taylor's influence, is impossible to tell. As principles are sound, clear thinkers in the field concerned are of course likely to arrive at them independently of one another. What admits of no possible doubt is that the position to which Taylor eventually progressed as regards costs and the technic he developed in this connection is only beginning to be understood by professional accountants as a group and by the industrial world as a whole.

This can best be appreciated by reference to an article entitled "What Is Wrong with Cost Acounting?" published by *Management Engineering* in its issue of July, 1921, six years after Taylor's death. The writer, G. Charter Harrison, referred to the "failure of a large percentage of manufacturers to adopt the methods of cost accounting approved by the majority of professional accountants," and ventured the opinion that "this refusal may be due not to a lack of progressiveness but to a deliberate judgment that the advantages to be gained from these methods are not of sufficient value to offset the expense of their acquirement." He then continued:

Recently the writer was present at a discussion between the general works manager and the chief cost accountant of a machine manufacturing concern whose name is a household word and whose cost methods would be regarded by many a professional accountant as the acme of perfection. The cost system maintained by the concern in question provides accurate monthly information as to the cost of every part, assembly, and machine manufactured, and as to the profit and loss made on each kind of machine sold during the month; and yet the general works manager was so dissatisfied with the results obtained that he was considering the adoption of a subsidiary cost system entirely independent of the official cost system maintained by the accounting division.

In a discussion with his chief cost accountant he expressed himself very strongly as to the lack of practical value in detailed cost data presented fifteen days after the end of the month; he drew attention to the absurdity of calling foremen to account for events which happened four or five weeks previously; he mentioned the fact that the operating division had set a cost standard for a certain new and important item of product and wished to know whether the cost department could advise him each day as to the variances from the standard cost of this article during the day previous. In view of the fact that the article in question involved the performance of several thousand operations and the cost system in force was designed with the sole purpose of showing the actual costs of finished machines monthly without reference to standards, the chief cost accountant very properly stated that to give this information daily would be a practical impossibility under the existing plan.

Let us now turn to the manuscript prepared by Taylor in 1909 for his Harvard lectures:

Cost accounts, under the ordinary management, furnish the great check which is needed upon the efficiency both of the superintendents, foremen, sub-foremen and workmen. Unfortunately, however, it is impossible to get accurate costs within a month after the work has been done. Fifteen to twenty years ago I looked upon a correct cost system as one of the most important among the various elements of management, and in fact devoted a large part of my time to introducing systems of cost and of expense analysis in manufacturing establishments. Now, however, under the modern scientific management, as far as they *influence cheapness of manufacture*, costs and expense analysis become, comparatively speaking, elements of lesser importance, and we generally leave them to the last in the introduction of our system. Our time and money is spent upon *the front end*, rather than at the rear end. We devote the energies both of the superintending and of the clerical force to seeing that *the workmen actually do the work fast, and do it right*, rather than to the collection of cost data. The daily task which every workman must perform renders cost analysis almost unnecessary, from the standpoint of economical management.

I do not mean that the cost system should not be introduced. Costs are needed, in many cases, in order to regulate the selling prices; also for the general education of the sales department, and for deciding upon the future lines of progress for the business. But under scientific management what was formerly their chief value, namely, helping to get a low cost of manufacture, almost entirely disappears. And, as I have said before, the time and money available for establishing a system of management should be spent, first, where it will do the most good. It is utterly impossible to introduce all of the elements of good management at the same time; therefore cost systems should wait until the last.

Here, again, is an extract from a letter written by Taylor under date of June 10, 1911, to Charles Conrad, a paymaster of the United States Navy:

My experience has led me to place less and less faith in accounting as a road to economy. At the best, accounting constitutes merely a sign post which points, if it is of the right kind, directly at the inefficient spot. It does not, however, in any way tell how this inefficiency is to be remedied, because accounts come, in nine cases out of ten, so long after the actual work has been done that, unless an immense amount of digging up labor is gone into, it is impossible, even where written records of every act of every man exist, to place your hand upon the immediate cause of the inefficiency.

As I told you, I think, when you were at the Tabor Company, we have found for economy that the record which is made up early on the morning of the day following the work, which shows how many men in each department failed to earn their bonus, is the most helpful record in promoting economy. It becomes possible then, the day after bad work has been done by anybody, to chase it right home, either to the foreman, the teachers, the tool department, planning department, or to the workman himself, and prove right then and there to the men or the department just what they have done that is wrong.

This is perhaps the simplest possible account to keep, and yet it results in a greater efficiency than all the balance of the cost accounts put together.

I think that any detailed cost accounts which you are sending to Washington, particularly relating to costs of individual pieces or parts of machinery or apparatus, or even to the cost of individual machines used on shipboard, will amount to very little, and will on the whole not pay for themselves in promoting economy, for the reason that those at Washington are too busy to properly analyze those accounts and to chase them home, and that they are too far away ever to make it worth while to make a special trip to the Navy-Yard to chase down a thousand and one slip-ups that are bound to occur. And if they start corresponding with their managers about these things, you will find that the whole time of the management will be taken up in correspondence, instead of promoting economy.

Our whole experience has been that the energy of those who were engaged in recording facts should be put to obtaining records which immediately follow the work, and therefore give immediate valuable returns, right at the plant where the work is going on.

The rule which I have finally adopted for all accounts is to ruthlessly put out of existence all kinds of reports and records which are not practically used by those for whom they are intended. It is the worst kind of red tape to make report after report, and to submit one account after another, which are not actually made use of and which do not result in economies greater than the cost of making out the reports.

It was Taylor's quick perception of the futility of *post-mortem* accounting that led him, back in the 1890's, to seize upon the principle of the monthly report, as contrasted with the annual or semi-annual. But the 1890's scarcely had passed before he realized the limitations even of the monthly report, as far as costs are concerned. He conceived that the question always to be answered is, *not were costs wrong, but are costs right.*

So he removed cost accounting from the general accounting department and placed it in the planning room, while at the same time tying up the cost accounting with the main books in the manner that since has become known as interlocking.

Placing the cost accounting in the planning room, he made it a by-product of operations, and thus got his costs *coincidently* with the operations. That is to say, the papers and slips he designed to plan and control operations became the documents on which was based both the cost and production records.

For instance [says Kendall], a ticket made up in the central planning department, when combined with the instruction card, serves to plan the work in advance; then it is used to control the order of work by being placed on a bulletin board; then it gives the workman his particular piece of work to do with its instructions how to do it. On this ticket [commonly called a job card] is stamped the time at which the work is begun and when it ends. This same ticket then serves to check off the progress of the work on the route-sheet. Then it goes to the accounting department from which the man's pay is made up. It is then redistributed and furnishes the labor cost of the particular operation on the cost-sheet of the job. From cost-sheets similar to this are summarized not only the costs on all jobs, but department expenses and charges which appear in each four-week period statement.[1]

If excuse be needed for the attention here given to the accounting feature of Taylor's system, it should be found in its large general significance.

His accounting affords a good example of his genius as an economist; he got his costs without any mechanism installed especially for that purpose; he got them as a by-product of the mechanism used in production and consequently with little additional expense.

Also it is a good example of how he kept any function of management from setting up to be an end in itself, of how he made each element subordinate to the whole. He put accounting in its proper place as pertaining to the inspection function or to the general checking up of results.

Again it is an example of how he made each element coördinate with all the others. Cost keeping is worthless without a means of accurately measuring the work done, or of determining definitely the point where one operation ends and another begins. This accurate measuring of work is done by Taylor's routing system. We have seen that without a proper system of apportioning stores, his routing system would have been subject to awkward and costly delays, and that such a system was provided by his balance of stores sheets. These sheets in turn supported the general accounting. They acted as stock ledgers for purchased or raw materials and for manufactured stock parts or finished products. Along with his cost sheets for work in process they served as the details of these accounts in the general ledger. And here was a perpetual inventory, as contrasted with the old method of currently recording transactions and balances only in the

[1] From address at Amos Tuck School in 1911.

case of cash; leaving materials, work in process, and finished product to be inventoried once a year.

His balance of stores sheets also illustrate how he made the accounting *a part of the control.* These sheets, kept in the planning department, not only account for what is in the store room, but also control what is there. As soon as the materials needed for a manufacturing order are determined (or an order is received from a customer for an article in stock), a slip ordering the stores room to issue the material is made out; and, says Hathaway,

> It is the Balance Clerk's duty to apportion in advance the materials called for on these issues, and subtract them from the quantities available [for apportionment or reservation]. After having drawn down his balance available, he compares it with his minimum quantity, shown at the top of the sheet. If the balance available is in excess of the minimum quantity, that ends the transaction; but if it is less than the minimum, he must issue an order for the quantity indicated for replenishment.

In fine, Taylor, as he developed his general system, made the same general accounting system permeate the entire plant; it was not something grafted on the manufacturing, but was a part of the very bone and sinew of the manufacturing. Thus he made all the information pertaining to the checking up of progress and results complete and lucid and readily obtainable at any time. All this he was able to bring about by his high coördination of departments and of functions, which made of the plant an organic whole; and back of it all lay his comprehensive analysis and classification.

CHAPTER IV

WITH MR. WHITNEY'S COMPANY

THOUGH Taylor's resignation from Midvale took effect in October, 1890, he and his wife maintained their home in Germantown until the following spring. From Germantown they took frequent trips to Madison, Maine, where one of the paper mills of the Manufacturing Investment Company was situated. Taylor also was frequently at the company's financial office in New York. In the spring of 1891, when their Germantown home was permanently closed, he and his wife took the first of their long journeys to Appleton, Wisconsin, where the other mill was situated.

Since he had an incurable aversion to traveling, it may be said that Taylor's new work involved him in unpleasantness from the beginning. To him a railway journey was an ordeal, and an ocean voyage a horror. Even when the automobile was perfected, he found a trip in one anything but a pleasure. He was prone to seasickness, and apparently was disturbed also by the motion of a car. Probably, however, his aversion to traveling chiefly was due to the suspension of normal activities it enforced upon him. With what was deepest in him craving the peace and quiet of the study or laboratory, there can be little doubt that if he could have consulted only himself, he early would have settled down in one spot to spend the rest of his days in experiment and invention. Activity of some kind he had to have, and this largely explains his horror of illness; a day spent in bed was to him as "a day taken out of one's life." It would seem also that it was as a cessation of activity that he dreaded death.

Not only was the traveling unpleasant for him, but he felt it was hard on his wife as it deprived her of a real home. Situated on the Kennebec River, about fifty miles south of Moosehead Lake, the town of Madison was in those days pretty much in the backwoods. Among the population of a thousand or two was a large sprinkling of French Canadians. The one hotel was of the commercial type that hugs the railroad station. On their second trip to Appleton the Taylors decided that, though Mr. Taylor would have to keep oscillating between Maine and Wisconsin, they would make their headquarters in the Maine town and there build a house. Returning with her husband to Madison, in July, 1891, Mrs. Taylor selected a site a mile or so out from the town at a point commanding a fine view of the Kennebec. From her plans the house was built of seasoned planks cut at the mill; long and low, with a large central room surrounded by a balcony, it remained the home of the Taylors for three summers and two winters.

It was here they had their first garden, a possession they prized in equal degree. Feeble would be the discernment of one who could scan the record of the minute study of the habits of grass that Taylor made at his later home, Boxly, without realizing how deep was his sympathy with the struggle of each tiny blade for life and expression. His interest in all living things was scientific, but not purely so in the sense that he wanted to know just for the knowing; there was that in him which made him long that each thing, after its kind, should attain perfection. The daisy owes no apology to the rose for not being a rose. But the daisy should be a first-class daisy.

The esthetic was not in his blood; moreover, no one could bend his mind as he did to the study of fundamentals without becoming more or less insensible to the appeal of pure beauty. But in flowers he found a form of beauty that appealed to him directly. Whenever it was possible he had them on his desk. We imagine, however, that if a love of flowers was native to him, he owed his continued enjoyment of them largely to his wife. It was she who kept him in touch with that part of life of which flowers may be taken as a symbol. In many ways his nature was enlarged through hers. As she was interested in pictures, in beautiful furniture, in objects of art in general, so was he.

It was a country where near-zero temperatures were made not only tolerable but enjoyable by the dry and crisp air. Frequently in weather like this they went horseback riding. Mr. Taylor was not much of a horseman; still, when he found that none of the horses at Madison had been specially trained for the side-saddle, he would not let his wife mount one until he himself had tried the animal out; and that he made the try-out thorough will be recognized when it is said that he rode the horse, not only in the side-saddle his wife was to use, but in a skirt borrowed from her. It is easy to imagine the awe with which the natives viewed this action by the city man; but Lord bless you! appearances never concerned Fred Taylor.

It became a lively place, this rustic home of theirs. To meet the situation created by Mr.Taylor's frequent absences in Appleton and in New York, Mrs. Taylor's relatives and friends came up for long visits, and among them there was sure to be at least one person proficient at the piano. Much entertaining was done for the young and more or less lonely city men who had come up to help run the new paper mill. It appealed to the ladies to give these young men an opportunity to spruce up there in the "backwoods," and it always was Frederick Taylor's principle to throw his home open to all who could come and enjoy it. For the young men at the mill he felt a deep responsibility. By day he ruled them imperiously, and in the evening gathered them into his home and explained the reason for it, expounding to them his doctrine of hard work and of grit and pluck and *get there.*

It will be recalled that it was in Maine that John Winslow, the Quaker minister-mechanic, and Thankful Hussey, that remarkable Quaker woman preacher, lived and taught their democratic religion. And now, just about a hundred years later, and about seventy-five miles north of the spot where they lived, we find their great-grandson; he also a minister-mechanic, he too a preacher.

Typical of the way Taylor dealt with his young men is the case of Charles L. Holmes, who in his later years became president of the Waterbury (Connecticut) Trust Company. "It is my belief," says Mr. Holmes, "that in a man's life he has only one great experience, and my great experience was meeting Mr. Taylor." Eventually Taylor sat down with Holmes, analyzed his capabilities, showed him that the work he then was attempting was not in line with them, and advised him as to the work he ought to take up. We can well believe that the talk was shot through with kindling thought and glowing word, and the value Mr. Holmes attaches to it can be read in the words of his just quoted.[1]

Another young man who there in Maine had his career influenced in a still more direct way was Sanford E. Thompson, destined to make an exhaustive application of Taylor's time-study methods to all kinds of work in the building trades, and to become one of the leading Taylor engineers in management. Upon his graduation in 1889 from the Massachusetts Institute of Technology with the degree of civil engineer, Thompson was employed by a pulp and paper company at Solon, Maine. Hearing there that the Manufacturing Investment Company was teaching young men the sulphite business,

[1] From the writer's own first-hand knowledge he considers it safe to say that there are literally scores of men in industry today who can trace the beginning of their development to some contact with Taylor's personality of power and fire.

he applied to this latter company for a position, and was employed by it in July, 1890. In the following year he became the superintendent of construction at the Madison mill, and stayed there after the mill was started.

In the process of converting wood into paper, the wood, along with sulphurous acid, is placed in a steel tank known as a digester, and there cooked with steam until it is reduced to the substance called sulphite pulp. A cooking then took about forty hours. Throughout this period the man in charge had to regulate the temperatures and pressures, and occasionally draw out a sample of the liquor; the cooking, now reduced to a science, then being a matter of individual judgment.[1] In the course of his training, young Thompson ran a cooking throughout the whole period of forty hours, and when it proved to be not a perfect one, volunteered for another trick at it to get it just right. Scarcely anything could have appealed to Fred Taylor more than that, and when Thompson later revealed a genius for patient investigation approximating that of his chief himself, a firm basis was laid for their permanent association.

Again with Mr. Whitney's company Taylor showed that the executive in him always was likely to lapse into the engineer, and his typical student's habit of becoming absorbed in his intellect often made him seem inconsiderate. It would appear, however, that sooner or later he always woke up. In his Madison office were five stenographers, among them the Miss Frances Mitchell who became his secretary many years later at Boxly. Frequently he did not come in to dictate until just before noon, and thus made necessary a scramble to get the mail off on the two o'clock train. "But," said Miss Mitchell, "he always eventually did something so nice as more than made up for the irritation he caused you." One day,

[1] In his later years Thompson was destined to return to the sulphite business in his capacity of consultant, and it was largely through his instrumentality that the cooking was reduced to a science.

for instance, he was seen approaching on horseback with something bulky wrapped in a newspaper. Again his disregard of appearances. But when in the office he removed the newspaper, what should appear but five bouquets of sweet peas. Incidentally he was much embarrassed when he found he had overlooked the girl who served as filing clerk. His solution of the difficulty was to have Miss Mitchell give her bouquet to that clerk, and on the following day Miss Mitchell received a bouquet twice as large as any of the rest.

His judgments of persons usually were good, and often keen and shrewd. He could become the victim of prejudices both against and in favor of men; but on the whole, especially in his later years, he applied his analytical mind to the study of men's characters and abilities uninfluenced by any feeling. A weakness he now and then exhibited was that of permitting himself to be imposed upon by men whose ability chiefly was that of "putting up a game of talk." With all his sagacity he suffered, in the manner of those who themselves are high minded, from being a little too ready to believe the best of people, and once he put confidence in a person, he withdrew it with extreme reluctance.

It would seem again that the ability of smooth talkers to impose upon him, especially in the years following those he spent with Mr. Whitney's company, was largely to be explained by the opposition he usually encountered — so accustomed was he to being opposed that, as it has been put with humorous exaggeration, "when a man showed symptoms of agreeing with him, he was ready to fall on his neck." True, it did have its humorous aspect, this and the fact that as he went on it became more and more so with him that no sooner did a man start to question one of his orders than he was likely to classify that man as one of "those damned kickers" and call on all his terroristic methods to reduce him to submission. Yet, bespeaking as it did the amount of opposition faced by this highly sensitized man with his student's love of peace and quiet, it also had its undertone not far removed from the tragic. In passing it needs to be said that whenever one of "those damned kickers" could prove to Taylor that he had the facts or reason or right on his side, no one could have been more appreciative than Taylor as that man stood up and refused to be dragooned.

Hint has been given that his three years with the Manufacturing Investment Company were not altogether pleasant. The fact probably is that they were the unhappiest of his life. Though he went into this new enterprise with all the zeal with which his nature was charged, things went wrong from the beginning.

The first big disappointment was in connection with the patents. What previously had blocked attempts in this country to make paper out of forest products was the problem of getting an acid-proof lining for the digester. The lining devised by Professor Mitcherlich was the solution, and it was supposed that the patents covering it were such that other persons entering the sulphite business would have to pay a royalty to the Manufacturing Investment Company. This proved so far from being the case that no sooner did the company get going than it had to face unrestricted competition. And this was the more trying in view of the fact that the mill sites in Madison and Appleton turned out to be not as advantageous both as regards water power and the supply of raw materials as other of the sulphite mills that came later into the field. It appears that everybody connected with the Company was in too much of a rush. Says William A. Fannon, who accompanied Taylor from Midvale:

There was a competitive spirit started between Admiral Goodrich [in charge at Madison] and Admiral Evans [in charge at Appleton] as to who would get his mill going first. The Appleton mill succeeded in making the first fiber; but in the haste to get these mills going, there were some unfortunate mistakes made in the designing, some of which were beyond the control of Mr. Taylor, as they were already made before he took charge. In this same rush, Mr. Taylor also made some mistakes, as did all the other men. In addition to this, there was inexperience as to what was needed in this new process.

It was two years before the finishing touches were given to the mill at Madison. As the building was partly up when Taylor came, he to a large extent had to design his machinery to fit into the building, whereas, of course, the only right way is to design the building to hold the machinery. And as the sulphite business was then in its infancy, he had no precedents to guide him.

At Appleton he found it hard to get along with "Fighting Bob" Evans; probably it was mostly a case of the natural clashing between a very positive person and a very pugnacious one. At Madison, on the other hand, his moral and physical courage won him the deep regard of that punctilious gentleman and gallant officer, Casper F. Goodrich, and a friendship was formed between them that lasted until Taylor's death. When Admiral Goodrich spoke at the outdoor memorial meeting held for Taylor at Boxly, he lifted his hat every time he mentioned his friend's name. "No man," says the Admiral, "has influenced my life in so many ways or to such great profit to myself as Mr. Taylor." Apparently we here have the clew to the love merging into reverence that Frederick Taylor was likely to inspire in his friends of all social ranks: calling forth the best that was in you, you were led to associate him with what you most respected in yourself.

The largest factor in making his years with the Manufacturing Investment Company unhappy was the lack of harmony that frequently was revealed between his principles and methods and those of the chief owners of the business.

It is said that early in his association with William C. Whitney, that gentleman remarked to him: "Taylor, you don't know the first principles of business." Asked to specify, Mr. Whitney said: "The very first principle of all good business is to claim everything and admit nothing." Doubtless Mr. Whitney spoke with playful exaggeration, and doubtless also Taylor did learn some valuable things from him; nevertheless, the probabilities are that there was that in the spirit of the remark which to a man like Taylor was jarring.

A concrete illustration of their differing points of view apparently is afforded by the contract for water power made by the Manufacturing Investment Company with the State of Maine. To Whitney, presumably, the all important thing was that this contract brought into use power that previously had been going to waste. To Taylor a very important part of it was that, at least in his judgment, this contract deprived the people of Maine of valuable rights without due consideration.

Another point of difference between him and Whitney had to do with what Harrah had called his habit of "making money fly." This habit of his, in fact, got him frequently into difficulty with the employers he had after leaving Midvale.

Viewing his work in the large, we can see that he was prodigal with money only as a great general is prodigal with lives; it was a present prodigality only, or one that arose from calculating the effect that a present expenditure may have in avoiding a greater one in the future. He always looked ahead and played for that which was best in the long run. When in his later years his management methods began to be taken up here and there, and some worried executive would complain that they did not seem to be producing the results expected of them, he was likely to reply: "Oh, wait a few years." His was the higher prudence of a royal mind; the prudence which does not refrain from spending, but spends well.

His first superiors at Midvale — Sellers, Brinley and Davenport — were, for their period, highly exceptional executives in their scientific training. And when the Harrahs took control, the ultimate economy of his methods had been largely demonstrated. Hardly was it to be expected that he should drop into such an environment soon again, and what we know is that the prudence, the economy, of most people is negative. It lies in avoiding. The present expenditure is real to everyone, but the future saving usually can be seen only with the eye of faith in the workings of natural law.

William C. Whitney was too big a man not to realize that mistakes are inevitable, especially when one is opening up a new field, and he was by no means a niggard. Yet he and his financial associates did have difficulty in understanding the large sums that the company frequently was called upon to lay out for machinery, and it irked Taylor to have his course repeatedly questioned.

It was not that he spent money for anything fancy. The rudest contrivance would serve as long as it did the work. As a matter of fact, he did not sufficiently take into account the real, if intangible, value that appearances may have in a factory. His method, as Admiral Goodrich tells us, was to capitalize a workman at three thousand dollars and thus conclude that he was justified in spending this amount for machinery as it did one man's work. His expenditures also were largely due to his policy of being thoroughly prepared for breakdowns, and here appears his horror of any suspension of activity.

My first important contact with Taylor was at Madison, Maine [writes one of his friends]; and while I was waiting for him in conference, I could not avoid overhearing his conversation with those who preceded me. It all sounded very businesslike and imperative; each man must keep hustling; each man must make his every move count; the work as a whole must proceed continuously and in spite of all obstacles. A superintendent came in to report that some work would have to stop, as a steel pulley had split; although a new one had been ordered, it would take a week for it to get there. Now, this would not do at all; the work must proceed; clamp the pulley together; replace it with some sort of spare pulley; make a wooden one; do something, no matter what or how, but *keep that shaft revolving*. In all my acquaintance with Taylor, I have found that the dominant idea behind all his undertakings.

Eventually he installed at Madison not only a complete alternate power plant, but duplicate line shafting for the entire mill. The expense of this was obvious to the company's financial backers, but what they could not see was the money likely to be saved by it. And here is an illustration of the difficulties he had with his later employers. Take it in the case of his system of caring for belting. Its expense plainly appeared on the books, but what never had been tangibly shown there was the cost of a breakdown of the belting, say, for half an hour.

To be sure, there is reason to believe that his duplication of machinery at Madison was a little too thorough. In the judgment of some of his subordinates who were called on to carry it out, the duplication sometimes caused a complication that offset its benefit. If so, it is an example, not only of his tendency to make his precautions excessive, but also of his habit of making his orders too absolute. However, it can be said of his work both as a mechanical and a management engineer that as he might bring about an oversupply of things, it often was due to a deliberate policy based on the principle that as it usually is impossible to hit the mark exactly, it is better to have an excess which can be pruned away than a deficiency which has to be made up, and that it is better to take too many precautions than too many chances.

One of the most elaborate and successful pieces of machinery he designed for the Madison mill was that which, operated by hydraulic power, lifted logs from the river to the bank, and, as needed, from the bank to the mill, and also served to load railroad cars with the mill's product. Some of his machinery was designed not so much to save money as to save human drudgery, and with this manifestation of his social instinct he again felt lack of sympathy between him and the company's principal owners.

Another manifestation of his social instinct caused a good deal of mirth and at the same time a good deal of kicking among the mill's employees. This was his course in putting the "barkers" to work in cages. The barkers stripped the bark from logs with revolving disks of edged steel, and the cages were designed to prevent passersby from knocking against them. Nevertheless, it was thought that this was "making a monkey of a man"; and it illustrates the general fact that even "safety-first" devices have to make their way against the ingrained conservatism of the mass.

His difficulties at Madison were not lessened by the general prejudice felt in that community against the city men who suddenly appeared there to establish the mill with its not very sweet smelling fumes. Here also Taylor encountered the most difficult class of labor he ever had to deal with. Whether of the native or the French Canadian stock, those laborers, generally speaking, were "sot" in their ways, and having no ambition to earn more money than was needed to maintain the low standards of living they had inherited, were accustomed to working or not working as they felt like it.

In the face of all handicaps, he made headway. It became the habit of those suspicious "backwoodsmen" to say of him, "That feller's square." On an extremely bitter night in midwinter, he returned to the mill to do more work. To him the watchman seemed insufficiently clad, and he insisted on that man's taking his own fur coat. Such actions as these made a stir, but we are not here to read any prompting save that of pure kindliness; the principle of *noblesse oblige* was in his blood. "Because of Taylor," says Admiral Goodrich, "the prejudice that had been felt in that community against city men generally was markedly lessened."

He was with Mr. Whitney's company from the spring of 1890 to the spring of 1893. In 1897 he wrote in a letter: "My remembrance is that piece work was pretty thoroughly introduced at the Appleton mill before I left the company. I think, however, that it was not much introduced at Madison." Having so much of his time taken up with machinery and financial problems and with getting the right men for the management of the mills, he had not had much opportunity to put the labor conditions on a scientific basis. However, the methods he introduced at Appleton were applied to the Madison mill after he left the company, with general results of a wholly satisfactory nature.

It will be recalled that, in 1897, Walter A. Simonds, for whose company Taylor then was doing work, wrote to Midvale to learn what Taylor's record there had been. A similar letter was addressed by Mr. Simonds to the Manufacturing Investment Company, and in replying from Madison, Clifton S. Humphreys, who had become the general manager of this latter company, said:

Your letter referring to Mr. F. W. Taylor has come to hand and in reply I would answer:

First: — Mr. Taylor did have full authority while with this Company and introduced his piece work system.

Second: — It is now much more extensively used by this Company than at the time of Mr. Taylor's resignation, having been applied more generally at the Appleton mill, where it was in force under Mr. Taylor, and since been introduced at the Madison mill with the same satisfactory results.

Third: — The facts speak for themselves. It cost by day work at this mill (and is now costing at other mills at present) from 18 to 20¢ per cord to bark wood. Under our present arrangement of piece work, it costs us 12¢ per cord and each man barks 60% more wood than by the day and with greater economy.

Formerly it cost us $2.75 to $3.00 to fill digesters. Now under piece work it is done for $2.00 with an additional saving of two hours' time on each cooking, which is more valuable than the saving in the cost of filling.

Again, we pay 3¢ per ton for unloading our coal, while it costs our neighbors, the Woolen Mills, with day work 5 or 6¢ per ton.

In general, under day work system, it costs about $20 per ton to make sulphite pulp, while last month, under systematic piece work, it cost us but $8.58 per ton and our production was nearly double that ever made by day work.

Had it not been for the piece work system, as inaugurated by Mr. Taylor, both the Appleton and Madison Mills would have been shut down during the dull times just past and the question of their ever starting up a most serious one.

Aside from professional duties too much cannot be said in Mr. Taylor's favor. As an engineer one has but to consider his work.

I shall be glad to take time and give you further information desired.

While Taylor remained with the company it became a fine operating success. We are informed that it finally turned out a quality of sulphite pulp that was generally recognized as the best. But the business panic that in 1893 swept the country destroyed the last hope of its having unusual earning power. In fact, there was now no immediate prospect of the company's earning anything. It was a blow to Taylor's personal finances; but wholly apart from any money considerations, he long since had decided to quit the company as soon as his contract expired.

CHAPTER V

HE STARTS A NEW PROFESSION

THE widespread financial storm of 1893 was some time in gathering; and papers left by Taylor show that at the beginning of the trouble he was persuaded to consent to an amendment of his contract with Mr. Whitney's company by which his salary was reduced and he agreed to pay for immediately several thousand dollars of the common stock and to pay for in installments several thousand dollars of the preferred. To pay for the common he had to sell securities for less than they had cost him, and to pay for the preferred he borrowed money on a note. Owing to the situation of his home in Madison and the entertaining he had felt obliged to do there, his living expenses had been high. And now, at the expiration of his contract, it was doubtful if the company would be able to weather the general financial storm. As a matter of fact, it did, and some of the money he put into it he recovered later; but for the time being he faced the wiping out of practically all his surplus.

Our information is that Whitney, feeling he had taken Taylor from Midvale, voluntarily assumed most of the responsibility for this situation, and did his best to keep Taylor with the company; first offering to relieve him of everything connected with the finances, and then suggesting that he take sole charge of the Madison mill and thus avoid the need of being so much away from home. Though he had questioned Taylor's expenditures, he continued to have great consideration for Taylor's energy, character, and general engineering ability. We are informed that he stated directly that it would be to Taylor's interests to remain in touch with him and the group of financiers with whom he was associated. He felt, in fact, that he could promise to make Taylor a millionaire within a few years.

What reasons Taylor gave for declining all of Whitney's offers we do not know. We do know, however, that dating from his association in the Manufacturing Investment Company with William C. Whitney, Daniel Lamont, and Colonel Oliver H. Payne, he conceived a great distaste for the general business methods of Grover Cleveland's inner circle of friends and for those of such groups of financiers who were allied with the Standard Oil interests.

He was an intense man; and as he went through life he probably found a needed outlet for his surplus of feeling by building up a regular little private chamber of horrors thickly populated by such creatures as Germans, theologians, politicians, professors, Standard Oil financiers, and a miscellaneous assortment of "liars" and "hogs." Even as it entertained his friends to have him trot out these his pet horrors and administer to them a good, sound, picturesque thumping, so he probably got a lot of amusement out of it himself. Yet it had in it much that was entirely serious, especially as regards the financiers.

"Throughout my life," he said in the address he made in Cleveland shortly before his death, "I have been very much inclined toward the radical side in all things." He most decidedly was not a Socialist — not, at all events, as Socialism stands for class consciousness, class hatred, class warfare, and blind adhesion to doctrinaire economic theories. But if protest against individualism unbalanced by considerations of a social nature, against capitalism devoid of consideration for human flesh and blood, and against financial privilege, makes a man a radical, he was quite radical indeed. No one could have denounced more vehemently than he the huge combinations of capital that grew up in his day, and it all came down to what he regarded as their "hoggish" course. Unless you provide for yourself, you can be of little service to others. Very good. But why not know when you have got enough? Why shove others aside? Why not, even while you are getting yours, help others to get theirs? Why not, even in business, be a gentleman? That, as we understand it, was the gist of his feeling.

The antipathy he developed to financiers was not limited to those who were associated with the big combinations. In 1911, when a naval constructor friend of his was thinking of retiring from the government service to become manager of a private shipbuilding enterprise, he wrote to this friend as follows:

> Personally my experience has been so unsatisfactory with financiers that I never want to work for any of them. If there is a manufacturer at the head of any enterprise, such as shipbuilding or construction work of any kind, and he is a large-minded man, that is the man whom I want to be under. As a rule, financiers are looking merely for a turn over. They want to get in and out of their business quickly, and they have absolutely no pride of manufacture. It is all a question of making money quickly, and whether the company is built up so as to be the finest of its kind and permanently successful is a matter of complete indifference to almost all of them.
>
> A good example of the utter lack of "proper pride" of the manufacturer is to be seen in the present managers of ———. They are among the leading financiers in Philadelphia and New York, and absolutely refuse to spend a cent for much needed physical improvements or for improvements in management. All that they are looking for is the chance to unload on some one else and get out whole.

He, of course, discriminated among financiers, but he felt that as a class they were interested more in juggling money from pocket to pocket than in bringing wealth into the world. He was repelled also by the tendency of bankers to foster safe and established concerns and frown upon new enterprises and daring ambition. He did not content himself simply with talking against this ultra-conservatism which tends to crush initiative and deaden the creative energies of the community. In investing his own money, he on principle apportioned a goodly share of it to new enterprises. And in his will he expressly charged that the executor of his estate should not feel, as those who hold a fiduciary office are likely to feel, that it was his duty first, last, and all the time to play safe.

Such an enthusiastic, intense nature as Taylor's always is subject to terrible let-downs; and he had one of these as the time came for him to withdraw from the Manufacturing Investment Company. "So great was this disappointment to Mr. Taylor," says Mr. Fannon, "that I think it affected his health." He was now thirty-seven years old; his savings were gone or had been placed where for the present they were unavailable; in the plain English to which he was devoted, he was out of a job; and business conditions throughout the country were in a state of great disorder.

He let nothing of this appear at home, except in so far as it was necessary to inform his wife of the need of their living, for the time being, very simply and economically. He not only invariably shielded his wife from worry, but acted in every relation on the principle that it was for him to share his joys abundantly while he bore his troubles alone. In going over the copies of the thousands of letters he wrote in his mature years, we found any expressions of complaint so rare that they stood out with the prominence of a few rocky upheavals on a gently rolling, sunshiny plain. Occasionally his letters might speak of the heartbreak that, in an inert, indifferent, listless world, must come to him who is himself all aglow with the spirit of forward march and up and at it; but of this his letters spoke only as you read between the lines. In his reticence there appears a very lofty pride, perhaps an extreme of pride.

"Tasks in hours of insight willed, can be through hours of gloom fulfilled." This was well illustrated by him in the spring and summer of 1893. While serving with Whitney's company he had discerned the need of a new profession, and in the hours of gloom immediately following his retirement from that company he prepared himself to practice it. How he came to discern its need is indicated in a letter he wrote in 1910 to a man who, while managing a business, was having a hard time trying to introduce system into it.

> I hope [said Taylor] you will not get discouraged, because you are meeting with exactly the same experience that everyone else does. I am sure it is in no sense your fault. In addition to this, however, you have undertaken a very difficult task, namely, that of running a shop at the same time that you are introducing a system of management. We [those then interested in promoting Scientific Management] in all cases insist that while the management is being introduced, a separate man be made superintendent of the shop, so as to leave the systematizer entirely free to make rapid progress. It was this difficulty of running an establishment and systematizing at the same time which originally led me to the idea that it would be a profitable business to give up the work of manager and become a systematizer. I believe I was the first man in this country to undertake this work as a profession.

In his use of the term "systematizer" we see his habit of calling things by their lowest names.[1] On his letter-heads and cards, however, he from the beginning called himself a consulting engineer.

[1] "The mark of the man of the world," says Emerson in his essay on Culture, "is absence of pretension. He does not make a speech, he takes a low business-tone, avoids all brag, is nobody, dresses plainly, promises not at all, performs much, speaks in monosyllables, hugs his facts. He calls his employment by its lowest name, and so takes from evil tongues their sharpest weapon."

A rubber stamp he had prepared reads as follows:

FRED W. TAYLOR, M.E.,
ROSS STREET, GERMANTOWN, PHILADELPHIA.[1]
CONSULTING ENGINEER
SYSTEMATIZING SHOP MANAGEMENT AND
MANUFACTURING COSTS A SPECIALTY

Essentially his new profession was that of the man who, representing himself to be expert in systemizing and organizing, offers his service to a business, not as a manager, but for this particular purpose only, and only for such time as may be needed to effect this purpose, his pay usually being arranged on a per diem basis. As it was called for in connection with his systemizing and organizing work, Taylor of course continued to practice his profession of mechanical engineer. Incidentally it is to be observed that his founding of the profession of what is now called the consulting engineer in management was another example of his constant tendency toward specialization arising from his instinct to be thorough. Certainly in his own case he did well to abandon the work of the manager and specialize in that of the engineer.

The beginning of all his *comprehensive* system of analysis, classification, and symbolization can be traced to his work with the Manufacturing Investment Company. His position as general manager of that company brought him in contact with all the activities of the organization, and perforce required him to deal with accounting.[2] And now that he was to become a professional "systematizer," he saw he must master accounting theory and practice.

[1] This address, that of his parents, was used by Taylor for mail purposes because up to the time he went to Bethlehem he had no settled abode.

[2] For designating items of expense he here had a crude system of symbolization. Here also appeared his first register of accounts payable, not as complete as later worked out. His "Daily Statement of Cash Transactions" shows he had begun to work out the principle of internal check; the cashier, while not having a special bank account, did have a special account on the books, deposits for this account being made by the treasurer.

Among the other providential features of his career was the fact that at the Manufacturing Investment Company he was brought in contact with the professional accountant, Basley, who, having done work for railroads, was in a position to acquaint him with the best accounting theory and practice of the time. It is not known what arrangement he made with him, but it would appear that early in June, 1893, when Taylor had done his last work for Whitney's company, he summoned Basley to his assistance. It is certain that, in this month, Taylor retired to his rustic home on the Kennebec and there struggled all summer long with problems in accounting, especially those relating to systems of costs and of expense analysis, and that later on he visited the offices of various railroads to look into their systems.

The general business conditions being what they were, he displayed a high courage in resolving at this time to establish himself in his new profession. The fact is that however he might descend from the heights of enthusiasm to the valley of disillusionment and discouragement, neither things present nor things to come, nor principalities, nor powers, could keep him there for long.

While he yet was in Maine he got in touch with the company destined to become his first client. This was the Simonds Rolling Machine Company, manufacturers of steel balls for bicycle bearings, with a factory at Fitchburg, Massachusetts. From Taylor's correspondence we gather that Walter A. Simonds, the principal owner of this company, was a young Boston man who then had not had much experience in business. Taylor had become acquainted with him several years before when his company acquired the right to use rolling machinery upon which Taylor held patents; our information being that, in return for this right, Taylor received stock in the company.

It was in September of 1893 that he and his wife bade farewell to their rustic home and went to Boston, where, not trying to disguise from themselves that their future was uncertain, and facing the fact that they must live on a scale commensurate with their actual circumstances rather than with their hopes, they found for the winter a boarding house the excellence of which was that it offered ample opportunity for the practice of the ancient New England virtue of plain living and high thinking.

At the beginning he fixed for his services as a consultant a charge of thirty-five dollars a day, and later increased it to forty. That seems a small sum in comparison with what even mediocre men doing similar work get nowadays, but it was a fair amount in those days. It is said that some of his prospective clients, pretending to misunderstand him, would remark: "Well, thirty-five dollars a week seems a good deal to pay for that sort of work." But he brought them around; he was a persuasive man, and masterful.

If when he left the Manufacturing Investment Company his fortunes were at their lowest ebb, the fact is that eight years later, when he left the Bethlehem Steel Company, he had accumulated a competency which sufficed to make him feel, with his prejudices against great wealth, that he no longer could afford to work for money. One explanation of the rapid rehabilitation of his fortune is that in the five-year period between his leaving the Whitney company and his going to Bethlehem he found some time to do promoting work. With his persuasiveness, his enthusiasm, and his technical knowledge, he had large talents for promotion; and if he had viewed money as an end in itself rather than as a means to an end, he might well have devoted himself to this work exclusively.

One of his promotions was that of bringing about a combination of manufacturers of road-making implements. The competition among these manufacturers had been of the cutthroat kind, and apparently this had led to a great deal of bribing of local politicians. It would appear also that, at least in some cases, the manufacturers were not so much the corrupters of the politicians as the victims of their rapacity. Be that as it may, it is said that while each of the manufacturers whom Taylor approached was entirely sure of his own spotless innocence, he was equally sure that all of his competitors were crooks. This general belief among them that everyone else was a crook naturally was an obstacle to getting them to come together, but Taylor at length overcame it. For his service he claimed a fee so large that some of the manufacturers wanted to cut it down. But the story is that when they conferred about it, one of the manufacturers arose and said: "No; that isn't right; any man who could get us crooks to work together deserves what he asks." And this was adopted as the view of all.

In promoting a combination of three chemical plants, he was brought in direct contact with a fine example of what in his paper of 1903 he called the "great unevenness, or lack of uniformity shown, even in our best run works, in the development of the several elements which together constitute the management." Each of these plants was strong in some one particular while weak in others; one was good at manufacturing, one good at selling, and one good in the financial end; the explanation being that each plant was strong in the particular department in which the head of the business had happened to receive his training. As a matter of fact, unevenness of management arising from this cause is practically inevitable wherever a plant is not run on scientific principles.

It might be thought there was something inconsistent between Taylor's promotion work and his antipathy to the large combinations of his day. Presumably he found that the evil of combination does not lie in the act itself, but in the object it is intended to and does effect and in the way the combination is conducted; and on the face of it, it would seem that the combinations he assisted to bring about were designed to eradicate clearly-existing evils and so served good social ends.

Though his patents, in the main, were unprofitable to him personally, he did in some cases realize substantial sums from them, as notably with the high-speed steel patents he sold to the Bethlehem Company. However, his accumulation of a competency in this period is chiefly to be explained by the way he invested his money.

Since his youth he had made, with his usual thoroughness, a study of the principles of investment. One of the first of these principles is to buy when everyone else is selling, and sell when everyone else is buying; and Taylor took good advantage of this in the years immediately following the panic year of 1893. These were the years of the free-silver agitation, and business men generally were in the doleful dumps. Taylor, however, took a long look ahead and became a bull on the ultimate sanity of the American people and, in consequence, on the future of America. So, keeping his expenditures low, he put his surplus money into the stocks that others were dumping on the market. Soon after the election of William McKinley to the Presidency in 1896 came a return of general prosperity, and in the Spanish-war year of 1898 business in many lines partook of a boom. Thus some of the stocks Taylor bought at panic prices increased in value as much as ten and eleven times.

Returning to his engineering work, we find that in December, 1893, three months after he and his wife went to Boston, he read his *Notes on Belting* at the New York meeting of the A. S. M. E. As writing was for him slow and laborious toil, he probably started this paper, if he did not complete it, at his home in Maine. This was his first important public utterance; important if for no other reason than that in it was to be read, by the discerning, his principle of relying on the scientific method. As a scientific treatise, however, it was entirely devoted to the subject of belting. The first statement of his management methods in general he reserved for his paper *A Piece-Rate System* read by him at the Detroit meeting of the A. S. M. E. in June, 1895.

CHAPTER VI

HIS FIRST STATEMENT OF HIS SYSTEM

BOTH as speaker and writer he was well served by his reasoning power, his immense sincerity, his instinct to *give out*, his very personality with its force and fire. It is plain, however, that he was not naturally articulate — it long has been a truism that your doer is seldom a sayer — and that the success he had in advocating the cause of science in management was, especially in the case of his writings, mainly due to will.

Rightly feeling that rules which apply to language addressed to the eye do not necessarily apply to language addressed to the ear, he cultivated distinct methods of speaking and writing.

Of Patrick Henry it has been said that he was "accustomed to throw himself headlong into the middle of a sentence, trusting to God Almighty to get him out." And it is reported of another celebrated orator, Henry Ward Beecher, that when some grammatical errors of his were called to his attention, he replied: "Young man, when the English language gets in my way, it doesn't stand a chance." The headlong dives Taylor took into sentences when speaking certainly might be called a caution, and what his pell-mell, repetitious, unconventional, even violent speech commonly did to the language in general was enough to give a pedant convulsions. Tremendously effective on the whole, it illustrates that, however it is with writing, what counts the most in speaking is audacity, dash.

When an engineering associate wrote to him to suggest that he should give a larger number of practical illustrations of the points he made in his *papers*, he replied:

I am afraid that the trouble is that the size of any such article would absolutely scare people off. They would not even start to read it. When you have a man pinned down in a chair for some two or three hours, he is at your mercy and you can feed him the kind of stuff you want, but when on the other hand he is asked to read a lot of stuff, he says, " Nay, nay, Pauline."

As all the papers he wrote on his system and philosophy of management were designed for presentation to the A. S. M. E., their shortness as compared with the magnitude of their subject was to some extent due to the rules of that society. In the main, however, their brevity was due to his own perception that the man he wished mostly to reach — namely, the " Tired Business Man " — was altogether too languid to give his attention long to anything in the way of writing. His writing style in general hardly could have been more concise, restrained, and chaste. Again there is the fact that if scientific men usually seem to feel that it is for you to struggle to understand them rather than for them to take pains to make themselves understood, it was with him the exact opposite. To make what he wrote understandable by and of interest to the greatest possible number of persons was the ideal to which he devoted grinding toil, even when his subject was a purely mechanical one. He would, in fact, go to great lengths in translating technical terms into every-day ones.

A few words now as to how his paper of 1895, *A Piece-Rate System,* fitted in with previous developments at the A. S. M. E.

For years after it was organized in 1880, no one connected with this society apparently had an idea that it ever would deal with anything save engineering technic in the purely mechanical sense. It was left for Henry R. Towne, in his epochal paper of 1886, *The Engineer as Economist,* to bring up the subject of management. And by a striking coincidence this was the year in which Taylor joined the society. Then the society's vice-president, Mr. Towne said among other things:

> To ensure the best results, the organization of productive labor must be directed and controlled by persons having not only good executive ability, and possessing the practical familiarity of a mechanic or engineer with the goods produced and the processes employed, but having also, and equally, a practical knowledge of how to observe, record, analyze, and compare essential facts in relation to wages, supplies, expense accounts, and all else that enters into or affects the economy of production and the cost of the product.

In general Towne's argument was that, to a surprisingly large extent, works management and the methods of dealing with employees react on costs, and that as the man who has authority over the works or shop must be a man of engineering training, the engineer should make a study of problems of management in order that he may be qualified to serve in this new capacity.

> A vast amount of accumulated experience in the art of workshop management already exists [continued Towne], but there is no record of it available to the world in general, and each old enterprise is managed more or less in its own way, receiving little benefit from the parallel experience of other similar enterprises, and imparting as little of its own to them; while each new enterprise, starting *de novo* and with much labor, and usually at much cost for experience, gradually develops a more or less perfect system of its own, according to the ability of its managers, receiving little benefit or aid from all that may have been done previously by others in precisely the same field of work.

In closing, Towne proposed that the society undertake to gather, by means of papers presented at its meetings, a stock of information regarding management. Essentially it was a plea for the recognition and the organization of "the Science of Management"; the plea being based on that principle of the higher coöperation for which Taylor came so firmly to stand; namely, that it is not permissible for men to go on repeating their experiences and experiments, that they should take advantage of one another's. How far advanced this paper was may be gathered from the fact that it was not until 1907 that the A. S. M. E. officially recognized management engineering, and that up to the time of Taylor's death in 1915 a large and influential section of the membership continued vehemently to deny that there could be any such animal as a science of management.

There has been much speculation as to the influence Towne's paper of 1886 had on Taylor. The opinion has been hazarded that it directly inspired Taylor to take up what proved to be his lifework; but we have seen that early as 1884 he had got well started on the development of his system. In a letter to the present writer, Mr. Towne himself states:

> I have no reason whatever to believe that Taylor's work was prompted by anything which I did or wrote, although there appears to be some ground for the belief that my paper may have awakened him to a realization of the significance of his own work, to the realization of the fact that a new Science was in process of development, and to the importance of presenting the fruits of his work to the engineering world by contributing a description of it to the Transactions of the A.S.M.E. I make no claim that this was so, and those interested must draw their own conclusions from the facts now available.

This much is certain: that if Taylor was great, Towne was his prophet. And in the years that followed Taylor became deeply indebted to this gentleman and scholar, not only for general inspiration, but also for generous personal support unwaveringly extended throughout times of acrimonious controversy. It testifies to Mr. Towne's broadmindedness that though as early as 1870 he began to systemize his own plant in a truly scientific spirit, he gladly acknowledged, when he had the opportunity fully to investigate, that Taylor had worked out the true course of a science of management.

Following Towne's paper of 1886 only four additional papers dealing with management were read at the A. S. M. E. up to 1895. Later in the year 1886 W. E. Partridge presented a paper, *Capital's Need of High-Priced Labor*, in which it was argued, very significantly, that the general problem of the employer was "to increase the earning powers of his men from year to year, and do it in such a way that the men not only earn more, but are more profitable to him." In 1887, Professor William Kent, author of the celebrated engineering handbook, read a paper on *A Problem in Profit Sharing*. In 1889 came Towne's *Gain Sharing*, this being descriptive of a modified form of profit sharing practiced in Towne's own plant.[1] Then in 1891 was presented Frederick A. Halsey's *The Premium Plan of Paying for Labor*, and to this celebrated paper we must give some attention.

What Halsey sought to correct was the evils of all three of the general wage systems then existing: day work, piece work, and profit sharing. Besides having other disadvantages, profit sharing in all its forms was like day work in that it made no direct appeal to individual self-interest. If there was an increase of profit, said Halsey, this always was due to the activity of the better workers, but the increased profit was apportioned *pro rata* among them all; the lazy and the shiftless being rewarded equally with the energetic and ambitious, with the natural effect of discouraging the better men. On the other hand, Halsey had found from his own wide experience that while the straight piece-work system was designed to appeal to individual self-interest and ambition, it seldom worked smoothly and never produced the results it should. A writer of skill, he vigorously attacked the evils

[1] According to N. P. Gilman's work on this subject, profit sharing, though systematically practiced in France as early as 1842, was not taken up in this country to any extent until the 1880's.

attending the rate-cutting which had become practically inseparable from this system because of the difficulty of foreseeing what the worker could do when stimulated by it.

His constructive plan was to start with the quantity of work which the worker had been doing in the past, guarantee to him his usual daily or hourly wages for this work, and then offer him a premium for doing more work; this premium to amount to about one-third of what the employer would pay for the extra work under the daily or hourly rate. That is to say, Halsey would divide the value of any increase over present production between the employer and the worker, in the proportion of about two-thirds for the employer and one-third for the worker. Thus if the worker even should double or triple his output, his earnings would not be excessive, and as the employer would get most of the gain, he not only would not be forced to cut the rate but would have little or no temptation to do so.[1]

After Halsey's, the next A. S. M. E. paper on management was Taylor's *A Piece-Rate System.* And the first thing here to be noted about this latter paper is that in it Taylor linked Halsey's premium plan with Towne's gain-sharing

[1] Though it was extensively practiced in this country, the Halsey plan apparently made its greatest appeal in Great Britain, and it would appear also that Taylor's paper of 1895, *A Piece-Rate System*, attracted more attention in that country than here. Following the publication of this latter paper, many British manufacturers organized something in the nature of a "rate-fixing department" — that is, instead of taking the worker's present or past output as a standard, they installed some apparatus for at least superficially investigating what the standard ought to be from an absolute point of view — and in connection with this used the Halsey premium plan. Though Taylor's method was different in detail, we know that he paid premiums to labor long before Halsey's paper was written; but on account of the earlier appearance of the Halsey paper and the inability of most people to realize that the important thing is not the particular wage-payment method, but the method by which standards for labor are set up, such Taylorism as took root in Great Britain following the publication of *A Piece-Rate System* was in general called "The Premium Plan." And it is not of little interest that when, in 1909, George Von L. Meyer became Secretary of the Navy and ordered thrown out the real Taylorism that under his predecessor had been introduced into the navy yards, what he eventually proposed to substitute for it was an emasculated form of it specially imported from Great Britain.

plan. True, there was between them this great difference: that whereas the Towne plan, like profit sharing, called for group action by the men, the Halsey plan, like straight piece work, called for individual action. However, the two plans were alike in the respect that *each took the workmen's present output as a basis,* and sought to induce and make it feasible for them to do better, by dividing the gain arising from their better efforts between them and the management. Thus Taylor said:

> Under this plan, if the employer lives up to his promise, and the workman has confidence in his integrity, there is the proper basis for coöperation to secure sooner or later a large increase in the output of the establishment.
>
> Yet there still remains the temptation for the workman to "soldier" or hold back while on day-work, which is the most difficult thing to overcome. And in this as well as in all the systems heretofore referred to, there is the common defect: that the starting point from which the first rate is fixed is unequal and unjust. Some of the rates may have resulted from records obtained when a good man was working close to his maximum speed, while others are based on the performance of a medium man at one-third or one-quarter speed. From this follows a great inequality and injustice in the reward even of the same man when at work on different jobs. The result is far from a realization of the ideal condition in which the same return is uniformly received for a given expenditure of brains and energy. Other defects in the gain-sharing plan, and which are corrected by the differential rate system, are:
>
> (1) That it is slow and irregular in its operation in reducing costs, being dependent upon the whims of the men working under it.
>
> (2) That it fails to especially attract first-class men and discourage inferior men.
>
> (3) That it does not automatically insure the maximum output of the establishment per man and machine.[1]

[1] In his paper of 1903, *Shop Management*, Taylor returned to the attack on what he called the "Towne-Halsey plan" with even more vigor.

In viewing Halsey's plan simply as a modification of Towne's earlier plan, Taylor dealt Halsey's pride of authorship a blow. But there was an excellent reason why the difference between the Towne and Halsey plans should have seemed to Taylor of far less importance than the likeness between them. In the respect that they both took present output for their basis, *they both represented a surrender where Taylor had gone ahead and fought and won.* That is to say, the Towne and Halsey plans were based on the supposition that it was impossible for the management to determine possible output. Both thus represented in effect a feeling of despair as to the possibility of fixing piece rates accurately and a resort to a compromise that would minimize evils. This was especially true of Halsey's plan. While Towne did not refer at that time to the question of determining possible output, Halsey made this frank statement when, at the A. S. M. E., he discussed Taylor's paper of 1895:

> If Mr. Taylor can determine the maximum output of the miscellaneous pieces of work comprised in the everyday operation of the average machine shop, he has accomplished a great work, and the present paper should be followed at once by another giving the fullest possible details of his method. It is this universal difficulty of determining the possible output which is at the bottom of the difficulties besetting the piece-work plan, and it was its contemplation which led the writer's thoughts to the Premium Plan. With that plan, the attempt to determine the possible output is abandoned. Present output is taken as the basis.

For years Halsey continued to disbelieve that there was any practical way of determining possible output, but eventually he was convinced by the hard logic of facts and very generously acknowledged it.

The fact that Taylor called his paper of 1895 simply *A Piece-Rate System,* with the cautious subtitle *A Step Toward Partial Solution of the Labor Problem,* signifies not merely that he yet was unconscious that involved in his work was the development of a *comprehensive* system and that he himself was deeply interested in the "labor end." The general talk in industry at that time was all of wage systems and profit-sharing plans designed to stimulate workmen, and for all his independence of thought, Taylor's sociability made him impressionable to the mental attitudes of those with whom he was in contact and to the general spirit of the day.

He described his then existing system as consisting of three elements: "(1) An elementary rate-fixing department.[1] (2) The differential rate system of piece work. (3) What he [the writer] believes to be the best method of managing men who work by the day," this latter having reference to his policy of "paying men and not positions."

The essence of the labor problem, he said, lay "in the universal desire [of workmen] to receive the largest possible wages for their time," coupled with "the desire [of employers] to receive the largest possible return for the wages paid." He called these "apparently irreconcilable" aims "perfectly legitimate." And he placed first among the advantages of the system he was describing that it lowered production costs while at the same time it increased wages.

The second advantage of this system lay in the fact that "since the rate-fixing is done from accurate knowledge, instead of more or less by guesswork, the motive for holding back on work, or 'soldiering,' and endeavoring to deceive the employer as to the time required to do work, is entirely removed." Among the other advantages which he said had been proved by practical experience was that "it automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages

[1] Elementary rate-fixing was what Taylor then called elementary time study.

and sifts out men who are incurably lazy or inferior." Lastly, it "renders labor unions and strikes unnecessary."

This position that Scientific Management makes labor unions unnecessary he adhered to until his death; and what he went on to say about these unions in his paper of 1895 continued to represent his general attitude toward them:

> The writer is far from taking the view held by many manufacturers that labor unions are an almost unmitigated detriment to those who join them, as well as to employers and the general public.
>
> The labor unions — particularly the trades unions of England — have rendered a great service not only to their members, but to the world, in shortening the hours of labor and in modifying the hardships and improving the conditions of wage-workers.
>
> In the writer's judgment the system of treating with labor unions would seem to occupy a middle position among the various methods of adjusting relations between employers and men.
>
> When employers herd their men together in classes, pay all of each class the same wages, and offer none of them any inducements to work harder or do better than the average, the only remedy for the men lies in combination; and frequently the only possible answer to encroachments on the part of their employers is a strike.
>
> This state of affairs is far from satisfactory to either employers or men, and the writer believes the system of regulating wages and conditions of employment of whole classes of men by conference and agreement between the leaders, unions, and manufacturers to be vastly inferior, both in its moral effect on the men and on the material interests of both parties, to the plan of stimulating each workman's ambition by paying him according to his individual worth, and without limiting him to the rate of work or pay of the average of his class.

The position he here took as regards profit sharing or "coöperation," as he then called it, he also maintained during the rest of his career:

> Coöperation, or profit sharing, has entered the mind of every student of the subject as one of the possible and most attractive solutions of

the [labor] problem; and there have been certain instances, both in England and France, of at least a partial success of coöperative experiments.

So far as I know, however, these trials have been made either in small towns, remote from the manufacturing centres, or in industries which in many respects are not subject to ordinary manufacturing conditions.

Coöperative experiments have failed, and, I think, are generally destined to fail, for several reasons, the first and most important of which is, that no form of coöperation has yet been devised in which each individual is allowed free scope for his personal ambition. This always has been and will remain a more powerful incentive to exertion than a desire for the general welfare. The few misplaced drones, who do the loafing and share equally in the profits with the rest, under coöperation are sure to drag the better men down toward their level.

The second and almost equally strong reason for failure lies in the remoteness of the reward. The average workman (I don't say all men) cannot look forward to a profit which is six months or a year away. The nice time which they are sure to have today, if they take things easily, proves more attractive than hard work, with a possible reward to be shared with others six months later.

Other and formidable difficulties in the path of coöperation are the equitable division of the profits, and the fact that, while workmen are always ready to share the profits, they are neither able nor willing to share the losses. Further than this, in many cases, it is neither right nor just that they should share either in the profits or the losses, since these may be due in great part to causes entirely beyond their influence or control, and to which they do not contribute.

It is highly significant that in this his first paper on managing men, Taylor issued this warning:

Whether coöperation, the differential plan, or some other form of piece-work be chosen in connection with elementary rate-fixing, as the best method of working, there are certain fundamental facts and principles which must be recognized and incorporated in any system of management, before true and lasting success can be attained and most of these facts and principles will be found to be not far removed from what the strictest moralists would call justice.

The most important of these facts is, that MEN WILL NOT DO AN EXTRAORDINARY DAY'S WORK FOR AN ORDINARY DAY'S PAY, and any attempt on the part of employers to get the best work out of their men and give them the standard wages paid by their neighbors will surely be, and ought to be doomed to failure.

Though his paper made about twenty-three printed pages, he had little to say about the standardization of general conditions, that very important element in his mechanism, the little being mainly this:

. . . not the least of the benefits of elementary rate-fixing are the indirect results.

The careful study of the capabilities of the machines, and the analysis of the speeds at which they must run, before differential rates can be fixed which will insure their maximum output, almost invariably result in first indicating and then correcting the defects in their design, and in the method of running and caring for them. . . .

But what is, perhaps, of more importance still, the rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop. . . . These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workman, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman.

Mainly because of this standardization, he was prepared to believe that the industrial world would be slow in adopting his methods.

From what the writer has said he is afraid that many readers may gain the impression that he regards elementary rate-fixing and the differential rate as a sort of panacea for all human ills.

This is, however, far from the case. While he regards the possibilities of these methods as great, he is of the opinion, on the contrary, that this system of management will be adopted by but few establishments, in the near future, at least; since its really successful application not only involves a thorough organization, but requires the machinery and tools throughout the place to be kept in such good repair. . . . But few manufacturers will care to go to this trouble until they are forced to.

It is his opinion that the most successful manufacturers, those who are always ready to adopt the best machinery and methods when they see them, will gradually avail themselves of the benefits of scientific rate-fixing; and that competition will compel the others to follow slowly in the same direction.

In replying to the members of the A. S. M. E. who discussed his paper, he said:

I am much surprised and disappointed that the elementary rate-fixing has not received more attention during the discussion. No better evidence could have been produced, however, of the crude and elementary state in which the art now stands, of determining the time to do work and of fixing rates, than that only one member of the engineering society which is in the closest touch with the manufacturers of the country should have most briefly referred to the matter, while thirteen engineers have discussed at length the less important matter of what kind of piece-rate to use.

If only because of the title of his paper Taylor largely had himself to blame for this; and here was one illustration of how his tendency to adapt his exposition to the mental attitude and capacity of the crowd worked out, in large measure, to do injustice to himself as an engineer.

All the previous A. S. M. E. papers on management had, like Taylor's, advocated extra-ordinary wages. But whereas the previous papers had advocated the payment of extra-ordinary wages to give workmen an incentive for doing more or better work, Taylor paid such wages to induce workmen to accept the standards determined by the scientific method.

There was, however, a practically complete failure to grasp this revolutionary difference.

At the same time, his paper did not fail to make a stir in some quarters. Speaking of its presentation, John R. Dunlap, founder of what was then *The Engineering Magazine* and now is named *Industrial Management*, says:

> I obtained a copy of it shortly afterwards, and was so profoundly impressed with its striking originality, that, waiving the prejudice against the reproduction of official Society publications, I determined that our readers certainly should have the benefit of such authoritative, practical, and immediately available information. Accordingly, in January, 1896, I reproduced the major portion of the paper with this strong editorial endorsement, viz.: "We regard it as one of the most valuable contributions that have ever been given to technical literature." [1]

Now, in 1894 Taylor dreamed a great dream and in *A Piece-Rate System* he told as much about it as he deemed wise, and in the following simple language:

> Practically the greatest need felt in an establishment wishing to start a rate-fixing department is the lack of data as to the proper rate of speed at which work should be done. There are hundreds of operations which are common to most large establishments, yet each concern studies the speed problem for itself, and days of labor are wasted in what should be settled once for all, and recorded in a form which is available to all manufacturers.
>
> What is needed is a hand-book on the speed with which work can be done, similar to the elementary engineering handbooks. And the writer ventures to predict that such a book will before long be forth-

[1] A list of references on the subject of *Scientific Management*, compiled in 1917 by the Technology Division of the New York Public Library, shows that previous to 1895 neither *The Engineering Magazine* nor any other publication in this field other than the A.S.M.E. *Transactions* had printed any articles on management. From 1895 on, however, these publications carried an almost steadily increasing number of such articles, until in 1911, the year after the introduction of this subject at the railroad rate hearings, the climax was reached with a total number of 219.

coming. Such a book should prescribe the best method of making, recording, tabulating, and indexing time observations, since much time and effort are wasted by the adoption of inferior methods.

In its entirety and its broad outline his vision was of books in which should be listed, together with the time needed for them, all those motions, properly studied and corrected, which men make in order to bring wealth into the world. Few ever gained any understanding of this dream of his. Since such articles and pieces are constantly changing, his idea was not to list and give the times (except as it might be by way of illustration) of the motions which enter into the making of particular articles or pieces. His idea was to have books devoted to the various trades, and to list, with their proper times, all the elementary motions that are common in these trades or pertain to the fundamental operations of a given machine — the motions that, as they are applied to the making of various articles or particular pieces, themselves vary only in their combinations.

What he dreamed of he set out to bring to pass; and so in his paper of 1903, *Shop Management*, we read:

Mr. Sanford E. Thompson, C. E., started in 1896 with but small help from the writer, except as far as the implements and methods are concerned, to study the time required to do all kinds of work in the building trades. In six years he has made a complete study of eight of the most important trades — excavation, masonry (including sewer-work and paving), carpentry, concrete and cement work, lathing and plastering, slating and roofing and rock quarrying.

Further on in *Shop Management*, after quoting the prediction he had made in his paper of 1895, Taylor said:

Unfortunately this prediction has not yet been realized. The writer's chief object in inducing Mr. Thompson to undertake a scientific study of the various building trades and to join him in a publication of this work was to demonstrate on a large scale not only the desirability of accurate time study, but the efficiency and superiority of the method of studying elementary units as outlined above. He trusts that his object may be realized and that the publication of this book may be followed by similar works on other trades and more particularly on the details of machine shop practice, in which he is especially interested.

His prediction of a book giving machine-shop times was, in particular, thought to be a crank's notion, since here the difficulties were immense; but it was a dream he never abandoned. To the end he continued to predict that such books would come for all the trades, saying in the address he made in Cleveland just before his death:

I have before me something which has been gathering in for about fourteen years, the time or motion study of the machine shop. It will take probably four or five years more before the first book will be ready to publish on that subject. There is a collection of sixty or seventy thousand elements affecting machine shop work. After a few years — say three, four or five years more — some one will be ready to publish the first book giving the laws of the movements of men in the machine shop — all the laws, not only a few of them. Let me predict, gentlemen, just as sure as the sun shines that is going to come in every trade. Why? Because it pays, and for no other reason. Any device which results in an increased output is bound to come in spite of all opposition; whether we want it or not, it comes automatically.

What he here did not tell was that he himself was bearing the expense of as well as directing the collection of machine-shop data then in progress. For his principal associate in this work he had Dwight V. Merrick, who first came in contact with him at Bethlehem. Taylor's sudden death in 1915 naturally was a blow to the enterprise that he and Merrick were conducting jointly, but eventually Merrick resumed the task, or as much of it as was practical for him to undertake by himself, and it now has borne fruit in his book entitled *Time Studies for Rate Setting.*[1]

The reason that, back in the early 1890's, Taylor started out to realize his dream by getting Sanford E. Thompson to make time studies in the building trades was that studies in these trades did not involve, as in other trades, great preparation in the way of standardization. His building-trade studies Thompson pursued almost uninterruptedly for nearly seventeen years; at first devoting much of his own time to them and later supervising the studies of men in his employ.

In Taylor's lifetime these studies resulted in the publication of two books: *Concrete Plain and Reinforced* (1905), and *Concrete Costs* (1912). Of these books Taylor and Thompson appeared as the joint authors. What Taylor wrote in his introduction to the latter book will apply to them both. "The writer," he said, "wishes to make it clear that the greater part of the credit (if there is any) for producing this book belongs to Mr. Thompson. The writer's part has been mainly that of suggesting the general methods to be followed and then acting as advisor, critic and financier of the enterprise." Speaking of both books, Thompson says: "Their success is due to Taylor principles."[2]

No matter what you do, even if it be the preparation of a

[1] Published by the Engineering Magazine Company, New York, 1919. In his preface Merrick says: "This volume is divided into three sections: The first presents the principles, methods and implements of time study; the second is an illustration of time study as applied to a line of machine tools — Gisholt boring mills — together with a series of tables giving the detailed times as established by study; while the final section, in the nature of appendices, includes times for a number of other kinds of work, and thus shows conclusively the wide adaptation of the principles and methods outlined." From this it should appear that Merrick's book, while not a realization of all of Taylor's vision, is a good start in that direction.

[2] Something of the import of these time studies in the building trades may be gathered from the fact that, whereas when construction costs ordinarily are figured, the cost of materials is listed in detail — so much for so many feet of lumber, etc. — the labor cost is given in a lump sum arrived at almost entirely through guesswork. On the other hand, the Taylor and Thompson methods are designed to enable the labor cost to be figured with the same accuracy as the cost of materials.

text book, search out the one best way, adopt standards, act in accordance with method, and thought-out principle. So Taylor, in those early days, enjoined upon Thompson. Some of your facts you will develop through your own experiments, but it is not enough to make your experiments with care; check them all up afterwards; make sure that all your facts work out, not merely on paper, but actually; prove them practically. Also you will consult authorities; not one authority only; the views of any one man are likely to be prejudiced or inaccurate; consult as many first-class authorities as possible; if their statements do not agree, sift out the reasons for the difference; think it out for the reader; modify it if necessary, but select the opinion you consider the best, and either omit the others or present them only incidentally; come to conclusions; be definite. At the start of each chapter give its essential elements and the conclusions to which it tends; at the beginning of the book present its essential elements as a whole; always conclusions first and reasons afterwards; your conclusions are what the reader wants; your reasons are interesting only in the light of your conclusions. Make your cross-references thorough. So Taylor instructed and advised Thompson. So, also, he prepared his own papers; and we can well believe that his method has had great influence upon the preparation of engineering reports and technical papers in general.

Nothing in connection with his profession was too small for him to question. Never, he told Thompson, erase anything on a tracing if blue prints have been made from the tracing; cross it out and mark it over; that will show that the blue prints and the tracing do not correspond. The common mark for feet (′) is likely to be confused with the common mark for inches (″); therefore indicate feet by the mark "ft." To check an article, do not use the common mark (√); place along side of it a perpendicular straight line; the gaps among such lines will plainly show up the articles not checked.

While in writing his papers of 1893 and 1895 Taylor surely was influenced by the consideration of the contribution he could make to the upbuilding of his profession, there is no doubt that there also entered into it a "moderate and seasonable regard" (to borrow William Penn's phraseology) for the strictly "ethical" advertising such papers give a professional man. Reprints of his papers bearing the impress of the rubber stamp to which we have called attention were circulated by him in quarters where he thought they would do the most good, and, as a matter of fact, they had influence in bringing him more than one client. As his fellow engineers almost without exception failed to comprehend the significance of his papers, it hardly is likely that they were comprehended by any mere business man. Surely, however, they had an impressive look and sound. And now let us proceed with the story of Taylor's adventures with his clients.

CHAPTER VII

THE THORNY PATH OF THE REFORMER

ECHOES of his adventures as a consultant are to be found in his correspondence as well as in his papers of later years.

In 1909 he wrote to a fellow worker in the field of industrial management: "I have found that any improvement of any kind is not only opposed, but aggressively and bitterly opposed, by the majority of men, and the reformer must usually tread a thorny path."

On the other hand, he realized that he had a tendency to go to the opposite extreme. "I am by temperament a reformer," he wrote to Ray Stannard Baker in 1910, "and feel that I am even perhaps too prone to advocate improvements; that is, that I am inclined to go faster in the direction of reform than is in many cases wise."

At all times he was acquainted with the philosophy of conservatism, and was in fact such a conservative radical that he got the bricks from both the extreme left and the extreme right. And if, in the days of his hard struggle with those who had, in Bacon's phrase, a "froward retention of custom" and "reverenced too much old times," he had difficulty in keeping himself from attempting to push men along too fast, it hardly was strange. To act at all is to overcome *some* resistance, and therefore to assume *some* headiness, *some* violence of direction. And holding the ideals he did in the time he did, Taylor either had to abandon them or fight for them good and hard. Moreover, much of the opposition he encountered was not merely such as was inevitable, but was, as Barth has expressed it, "downright malicious and damnable."

Something of the imperious attitude he assumed towards his clients appears in a letter he wrote in 1910 to a young French engineer.

> With regard [he said] to the kind of contract which you ought to make with the ———, this is rather difficult to describe minutely. I always personally insist that in all essential matters relating to the management, the company for which I am working must do as I tell them, and the only way in which I have been able to enforce this is that I hold myself free to withdraw from the work at any time, in case they refuse to follow my directions. I have therefore not made contracts extending beyond two or three months.

Evidently his feeling against long-term contracts started while he was with the Manufacturing Investment Company. Not only did he, as a consultant, refuse to enter into any more of them, but in the years that followed he advised other engineers to beware of them.

If he demanded that his clients must do what he, the expert, said, he always was at pains, on the other hand, to explain in advance and in writing as much as possible of what he proposed to do and to see that it was understood by everyone, directors included. Whether in contracting to do work for others or to have work done for him, he was a great hand for having everything put down in black and white with a wealth of detail designed to prevent misunderstandings. As from a client he demanded full authority, so he assumed full responsibility. If, through any mistake of his, a client suffered material loss, he, all other things being equal, stood ready to make good the loss out of his own pocket. But his slogan was, "no responsibility without authority."

He had some sad experiences with directors, especially with those of the type of local capitalist; men whose horizons are bounded by their communities, and who are particularly prone to consider that, regardless of the workmen's production, the local labor market is being spoiled and the company is being robbed if the workmen are paid anything higher than the local prevailing rates. That he came to have definite ideas of how directors should function and of what their relations should be to the chief executive, will appear from this quotation from his Harvard lectures:

Usually the board of directors consists of men who are elected because they own a large part of the stock of the company, or because they represent others who own this stock. They *should* be selected, however, not because of ownership of stock but mainly because of their especial knowledge and experience in some one or more of the broad sections which together make up the business. For instance, one man should be selected for his financial knowledge, another for his general knowledge of the subject of management, a third for his technical knowledge of the needs of the trade and general knowledge of the selling side of the business; a fourth, perhaps, for his legal knowledge, and yet another for his engineering knowledge which should fit him to direct progress in this line. A board of directors consisting of specialists of this kind is vastly more efficient and better able to manage the business, even although they may personally represent but a small part of the financial holdings, than are boards as usually constituted.

The president of the company, or the chairman of the board of directors — it is a matter of name merely — should virtually be the king of the whole business, and should lead his board of directors rather than be a tool to be guided by them in detail; and when it becomes impossible for the president to lead in the carrying out of the general policy of the board, another man should be selected for the head of the business who is in harmony with their wishes and competent to lead them.

Now, the proper functions of the board of directors would be, for instance, to select, after having had proper evidence presented to it, the broad and general type of management to be introduced in the establishment. For example, whether it shall be "task management" or "initiative and incentive." After having done this, and after having broadly stated the policy of the business, as to payment of wages and salaries, they should not mess into the detail of the personnel — by ordering the president to employ this man, or discharge that man, or promote another man — nor should they vote a reduction of wages or an increase of wages contrary to the leadership of their president.

Other functions of the board of directors should be, for example, dictating the broad policy to be followed in the sales department, namely, the general character of the goods to be manufactured and sold, and the general type of the selling organization — whether the sales are to be mainly conducted through agencies or traveling salesmen, and the extent and kind of advertising to be used. Again, however, the details of the executive work should be left under the direction of the president. The general financial policy of the company should also be one of the functions of the board of directors, as well as the broad lines along which progress is to be made. That is, the decision as to the type of new product to be manufactured and sold, and the volume of business which is to be prepared for.

The world's experience in all directions has demonstrated the utter impracticability of successfully doing executive work under the management of a body of men, either large or small. An executive committee of one is the best committee to have charge of executive work.

The president of the company should be free to have as many advisers around him as he wants, and these men can be called executive committee as well as by any other name; *but their duties should be those of advisers.* In all executive acts, they should be under the orders of the president, and they should not be allowed to control his acts by a majority vote. He should, in principle, occupy the same position as the President of the United States. He should be free, practically, to select his own cabinet, and then should be in complete command of these men. The men under him should be free *to advise him in the most emphatic manner,* but the final decision in all matters should *rest with him,* and the board of directors should not entertain nor act upon appeals made to them from the cabinet officers beneath the president.

Directors, too, should specialize, but they should direct only in the sense that the course of a ship is directed when it has been determined to what port it shall sail. This done, the detailed business of getting there must be left to the captain. Naturally Taylor was compelled also to hold that the "captain" should be as free from interference from those below him as from those above. He was as much opposed to the brute power of sheer numbers as to the brute power of mere money.

His principle of undivided control did not, as we have seen, comprehend that the authority of the "captain" should be absolute or plenitudinary. Just as on a modern ship the authority of the captain does not extend to the running of the engine room, but is there limited by the specialized knowledge of the chief engineer, so Taylor's system everywhere limited authority as one form of specialized knowledge touched another. And in these years when he was developing various elements of his system, this indeed brought him trouble. Frequently in his writings we hear echoes of the cries of pain that came from old-school bosses as he stripped from them many of their functions and robbed them of their "authority" — that is, their power to deal arbitrarily and capriciously with the men under them. "As a rule, the writer has found that those who were growling the most, and were loudest in asserting that they ought to be doing the whole thing, were only one-half or one-quarter performing their own particular functions."[1] The smaller the man, the bigger, apparently, he wants to feel; and only gradually is it made manifest that as men are compelled to specialize they become possessed of more real authority than they ever had before. Again we read:[2]

> Through some means (it would almost appear some especial sense) the workman seems to scent the approach of a reformer even before his arrival in town. Their suspicions are thoroughly aroused, and they are on the alert for sweeping changes which are to be against their

[1] *Shop Management*, p. 145.
[2] *Ibid.*, p. 136.

interests and which they are prepared to oppose from the start. Through generations of bitter experiences working men as a class have learned to look upon all change as antagonistic to their best interests. They do not ask the object of the change, but oppose it simply as change.

One of the forms his realism took in this period was that of making a broad distinction between men of the rank and file and men of the officer class, in that the former men are used to taking orders and the latter men are not. Thus, in "making men get in line," as he called it, he had two different methods; and among some notes he jotted down we find the methods he used with the average man of the rank and file: "Rarely reason with him; never match wits with him; throw him onto the defensive; take short steps one after another in quick succession without talking about them, at least until after they are taken; set object lessons for men to see." In dealing with men of the officer class he at least attempted to explain, even as he did with such individual workmen as appeared to him could best be handled by appeals to their reason. The object lessons upon which he chiefly relied to carry conviction to the rank and file were set up by him at the earliest possible opportunity, and evidently never failed to be effective. Always the great difficulty came from men in the management.[1]

As in this period he moved in the direction of segregating planning from execution and of employing men to specialize in the planning, this brought him in conflict with what he

[1] Experience others have had in developing Scientific Management indicates that the difficulty of getting the workmen in any particular establishment to adopt the new methods always is in nice proportion to the lack of consideration that there has been shown them in the past. Where working people have been well treated for years, they naturally lose much of their age-long suspicion and fear of change. When Taylor was "systematizing," neglect, if not abuse, of employees was the usual thing. Not only this, but all such methods as his then possessed a fearsome novelty that they are far from possessing in these days of progressive education and development of working people, at least in the larger or more "civilized" communities.

referred to as the "almost universal belief" of manufacturers that "for economy the number of brain workers or non-producers, as they are called, should be as small as possible in proportion to the number of producers; i.e., those who actually work with their hands."[1] He vigorously attacked this idea in his management paper of 1903 and again in his metal-cutting paper of 1906. Writing in 1912 to the chief clerk of the inspection department of the Boston Navy Yard, he said:

> It has been my observation that there is no definite relation of any kind in the ratio of overhead expenses to direct expenses in the prosperity of a company.
>
> This ratio will vary very greatly in exactly similar companies, and yet both may be prosperous. Of course if there is a very great overhead expense, particularly if there is a great deal of so-called "non-productive labor" used, which is not used efficiently, this is a bad thing. I have found, however, that those companies which are managed in the very best way and which are earning the largest dividends in relation to their competitors, have the largest ratio of overhead expense to direct expense.
>
> I have in mind very particularly one of the most successful companies in this country of this kind, in which the direct or overhead expense is four times as great as the direct labor used; and as a general rule I can say that the more men you can have working efficiently in the management, that is, on the management side, the greater will be your economy.
>
> No greater mistake can be made than to assume that economy is realized by cutting down the so-called overhead expense. Just the opposite is true in the very best managed companies.

It has been pointed out that when manufacturers call brain workers non-producers, the laborer hardly can be blamed for believing that all those who do not toil with their hands are bloodsuckers. But the fact is that, with the simple and

[1] *Shop Management*, p. 121.

unconscious following of tradition that prevailed in industry in the 1890's, the various factors entering into production were known, even by employers, only as a matter of general and hazy impression. As in his progress towards scientific analysis in this period Taylor was far ahead of the executives of his time, his voice naturally was as one crying in the wilderness.

Before he went to Bethlehem in 1898, his principal clients, in the order he began to do work for them, were the Simonds Rolling Machine Company, with plant at Fitchburg, Massachusetts; the William Cramp & Sons Ship and Engine Building Company, of Philadelphia (commonly known as Cramp's shipyards); the Northern Electrical Manufacturing Company, of Madison, Wisconsin; and the Johnson Company and the Lorain Steel Company, two allied concerns having mills at Johnstown, Pennsylvania, Lorain, Ohio, and Cleveland, Ohio. In the case of all these companies, Taylor's engagements with them largely overlapped. Still another concern for which he did some important work in this period was William Deering & Company, of Chicago, manufacturers of agricultural machinery, whose plant later became one of those of the International Harvester Company.

Immediately after his conference in Boston in September, 1893, with Walter A. Simonds, principal owner of the Simonds Company, Taylor was authorized by that company's directors to look into its management. At this time his method was to consider the accounting end first; he readily convinced the directors that a new accounting system was needed, and his work for the company in this and other particulars extended well into 1894.

Now, it is probable that ever since he left Midvale, he had had pangs of regret at his separation from his first love, the machine shop, and had been longing to continue his metal-cutting experiments. At all events, he, in the summer of 1894, utilizing the reputation he had acquired among men influential in Philadelphia's industrial activities, proposed to the Cramp Ship and Engine Building Company that he reorganize its machine shops. His proposition being accepted, he began this work in the fall of 1894 and continued with it until the following spring.

It would appear that he was helped in obtaining Cramp's shipyards as a client by his paper of 1893 on belting, and it is certain that his paper of 1895, *A Piece-Rate System,* brought him as clients the Northern Electrical Manufacturing Company, the Johnson Company, and the Lorain Steel Company. For these latter companies he did work off and on during 1896.

In the latter part of this year he was summoned back to Boston by the persons principally concerned in the ownership and management of the Simonds Company, they having become dissatisfied with the man who for seven or eight years had been the general manager of their works in Fitchburg. Asked what he could do to help them out, Taylor demanded that he be placed in sole control of the shop until April, 1898, and eventually this demand was agreed to by formal resolution of the directors.

The rolling-machinery patents through which he became acquainted with the Simonds people were among those taken out by him while at Midvale. What his position was with reference to the moot question as to whether the inventions of an employee are his own property or the property of his employer, he made clear in a letter written in 1914 to Hans Renold, the head of a large engineering firm of Manchester, England. In the agreement made by this firm with its employees it was stated that all patentable inventions made by them should become, for a due consideration, the property of the firm, and in commenting on it Taylor said:

> Personally, when I was employed by a company, I always refused to sign an agreement of the general nature of the one you offer. I

insisted that I was unwilling to gamble as to whether I could or could not make inventions. On the other hand, whenever I made an invention inclusive in the line of the company I was working for, I assigned it over to them. But when I made inventions which would apply to many other lines outside of theirs, then I gave the company I was working with merely a "Shop Right" and kept all of the balance for myself. I never have regretted doing this, nor do I think that the company ever regretted the arrangement.

That in the period with which we now are dealing he set great store on his patents is indicated by his concern as he heard they were being infringed. "While Taylor was reorganizing the Simonds Company," says Wilfred Lewis, "he incidentally developed his ingenuity as a detective, and succeeded in trapping a number of concerns suspected of infringing his patents. Although I have forgotten the details of these exploits, the impression they made at the time was one of admiration and amusement not excelled by any of the Sherlock Holmes stories I have since read."

Beginning with 1886, there was scarcely a year when one or more patents were not issued to him in connection either with his professional work or with his purely personal activities such as devising improved implements for tennis, golf, gardening, hothouses, and moving trees. However, his general experience with patents was such that he came to regard them as useful for little else besides that of pegs marking stages in the march of progress. Writing in 1911 to Wilfred Lewis, he said:

I must confess that my whole interest in patents has been seriously shaken during the last few years. The chances of sustaining even a good patent seem to me about only one in three or four, and aside from scaring competitors away, which they do to a certain extent, I feel that they are more or less of a delusion and a snare.

A few months later in 1911, replying to a young man who had asked him for advice, he wrote:

As far as invention is concerned, I advise all my friends to give up any idea of making money through patenting. If you patent a good invention, it is absolutely certain to be stolen, and then you have not only the expense but the very great aggravation of a protracted law suit, so that my experience would indicate the undesirability of placing any money-making hopes in patents.

Of course if you look upon the patent as a means to get credit for your invention, this is all right. However, all this is no reason for anyone giving up making inventions, as a matter of pleasure. I think there is no greater pleasure to a man of inventive faculty than exercising this faculty, but no greater mistake to my mind than to get a strong hope of making money by it.

A great deal of the difficulty over patents he attributed to the fact that the judges who pass on them are not trained in mechanics. In another letter he spoke of the "necessity of a better patent court," adding that "it is impossible for these lay judges to do anything more than guess at the whole subject."

While he was serving as a consultant previous to going to Bethlehem, he and his wife necessarily were without a settled abode, and for his wife's sake it concerned him a great deal. Hers was not a rugged constitution; she was keenly sensitive to her surroundings, and her health in this period frequently was not of the best. In 1913 Taylor was asked by Dean Gay of Harvard's Graduate School of Business Administration to take charge of an advanced course in Scientific Management, and in declining the position he wrote:

One reason which, if there were no other, would be controlling is the fact that Mrs. Taylor is entirely devoted to her home in Philadelphia. She spent many years of her life in sacrificing herself while she traveled with me when I was introducing scientific management. During this time she lived in many cases in the most meagre quarters, and was obliged to be entirely away from her friends for months at a time.

In the summer of 1894, they were able to leave their "meagre" boarding house in Boston, and stay for a while with Mr. Taylor's parents in Germantown. During the winter of 1894–95, when he was at Cramp's shipyards, they had an apartment in Walnut Street, Philadelphia. In the spring they returned to Boston, and for the rest of the year of 1895 made their headquarters in an apartment in that city. Early in January, 1896, they went west; and until the following fall, as Taylor did work mainly for the Northern Electrical Manufacturing Company, the Johnson Company, and the Lorain Steel Company, they made their headquarters at various times in Cleveland, in Chicago, and in Johnstown, Pennsylvania.

By no means without compensation did they find their journeyings. Writing to a professional associate in 1910, Taylor said:

> The years which Mrs. Taylor and I spent away from Philadephia were at the time very trying ones, and yet we both look upon this period as the most developing, perhaps, of our lives. We were obliged to mingle with people from all parts of the country, and as a result we found the finest kind of men and women living in all ranks of society, and in the smallest and most out of the way places. We both value this experience, because of the enlarged sympathies which it gave us for our own kind.

In closing his letter, he said:

> You of course know yourself the nature of the work involved in systematizing. It involves a mingling of war and peace, of hard blows and tact, which gives one rather a trying life, and I can assure you that this was no less true in the past than it is now. It was a life full of disappointments in many respects, and yet full of great satisfaction whenever results were achieved.

Looking back, he always found that the big thing was the accomplishment. Nevertheless, the disappointments were bitter at the time, and one of the greatest of these he had at Cramp's. To his work at this place we must give some detailed attention; for while it was cut off in untimely fashion, it has much of importance, especially in connection with his general metal-cutting investigation. In fact, the great high-speed steel discovery he was destined to make at Bethlehem was the direct outcome of the experimenting begun by him here.

CHAPTER VIII

AT CRAMP'S SHIPYARDS

BUILDING ships mostly for the government, Cramp's was a large, old-established, widely known, and financially strong company. At the same time, its then existing shop management was exceptionally poor, and no doubt Taylor there set out with high hopes to accomplish great things. It soon proved, however, that he hardly could have got into a worse place, so far as any understanding of his scientific economy was concerned.

Before us is a copy of the "preliminary report" that, under date of September 19, 1894, he submitted to Edwin S. Cramp, "superintending engineer," after he, Taylor, with some of the company's operating chiefs, had "gone over several of the small details in the shops." This report shows that, after due experimenting, he proposed to bring about standard conditions as regards (1) belting, (2) automatic tool-grinding, (3) tool rooms, stores rooms, and tool making, and (4) the speeding of the machines.

In first giving his attention to the standardization of such things as these, he, as regards the introduction of scientific methods into a shop (and he was employed at Cramp's to deal with the shops only), was beginning at the beginning, at least from the practical point of view.[1] If there are various kinds and types of implements in various conditions,

[1] From the strictly logical viewpoint, the work would begin by laying out the shop's general plan of organization, including a clear definition of function, authority, and responsibility. That the logical is often far removed from the practical is indicated by the fact that if Taylor had begun at Cramp's by defining the functions of the various officials and thus limiting their authority, he undoubtedly, as the very first thing, would have had on his hands a fine old disturbance.

no proper order or system in the shop is possible. There must be uniformity, if nothing else.

> In the type of management advocated by the writer [said Taylor], this complete standardization of all details and methods is not only desirable but absolutely indispensable as a preliminary to specifying the time in which each operation shall be done, and then insisting that it shall be done within the time allowed.
>
> Neglecting to take the time and trouble to thoroughly standardize all of such methods and details is one of the chief causes for setbacks and failure in introducing this system. Much better results can be obtained, even if poor standards be adopted, than can be reached if some of a given class of implements are the best of their kind while others are poor. It is uniformity that is required. Better have them uniformly second class than mainly first with some second and some third class thrown in at random. In the latter case the workmen will almost always adopt the pace which conforms to the third class instead of the first or second. In fact, however, it is not a matter involving any great expense or time to select in each case standard implements which shall be nearly the best or the best of their kinds. The writer never has failed to make enormous gains in the economy of running by the adoption of standards.[1]

If standardization now can be brought about in a machine shop without any great expenditure of time and money, this was not the case when Taylor was at Cramp's. To be sure, he would have had a comparatively easy task had his aim been uniformity merely. But what he sought was the best from the point of view of scientific or ultimate economy. And while the exhaustive experimenting with belting he had done at Midvale enabled him, in comparatively short order, to set up in this particular at Cramp's standards that were reasonably satisfactory even to him, much experimenting had to be done to establish scientific standards in connection with the cutting tools and the speeding of the machines. And this

[1] *Shop Management*, p. 123.

mainly was because there had come into general use since his Midvale days tools made of the type of steel known as Mushet or self-hardening or air-hardening. As regards the speeding of the machines at Cramp's, this was there, as it is everywhere, though many manufacturers still seem unable to comprehend it, largely a matter of studying the possibilities of each individual machine, and the Barth slide rule, which enables scientific feeds and speeds to be determined quickly, had yet to be developed. This aside, the whole problem of speeding the machines naturally had to wait upon the determination of shop standards for tool steel and the establishment of standard practice for the shaping, care, and use of these tools.

It has been said that since Taylor's Midvale days there had come into general use the type of tool steel variously called Mushet, self-hardening, and air-hardening. It is to be understood, then, that previous to this the only type of tool steel known to the trade was the ordinary or carbon steel (so called because carbon is the "controlling" element), which, made by the crucible process, had served for all sorts of cutting implements, including weapons, since time out of mind. Now, it was the coming into use of the Mushet steel that directly led to Taylor's high-speed steel discovery, and it is important for us here to know just what the situation was as regards this Mushet steel when Taylor went to Cramp's in 1894. He himself has pictured this situation as follows:[1]

Some time between 1860 and 1870, Robert Mushet of the Titanic Steel Company in England made the discovery that if a considerable amount of tungsten was added to tool steel in combination with a larger percentage of manganese than had been before used, the presence of these two elements with carbon in the steel produced the curious effect of causing the tool to be almost as hard when cooled slowly in air from a forging heat as carbon tools when cooled in

[1] *On the Art of Cutting Metals*, pp. 219–221.

water. Because of this peculiar property, the Mushet tools were called in England self-hardening tools and later in this country air-hardening tools. . . .

For many years the tool steel developed by Mushet was looked upon largely as a curiosity. Gradually, however, the managers of machine shops found that by using tools made from the Mushet steel they were able to cut hard forgings and castings which were difficult to cut with the carbon tools. When this knowledge became quite general, it was usual for the best machine shops to have a few Mushet tools on hand for cutting specially difficult work, and their use for this purpose grew steadily from year to year.

It was not, however, until about 1890 that there was at all a general awakening among managers of machine shops as to the whole question of the cutting speeds of tools, and it may be said that practically up to that time Mushet tools had not been used for the purpose of gaining an increase in cutting speed. In fact, up to the time of our experiments of 1894–95 [at Cramp's], but few machines, if any, had had their driving speeds increased with a view to profiting by the possible gain in cutting speed obtainable through Mushet or other self-hardening tools.

It was in 1894 that we first had the opportunity to make a careful series of experiments to determine the relative cutting speeds of the Mushet and the carbon tools. We had hitherto been prevented from doing so by the fact that the Midvale Steel Works manufactured and sold tool steel, and up to the time the writer left their employ, they had not gone into the manufacture of self-hardening steel, and therefore would not allow us to make any experiments with it.

Before we give the outcome of these experiments of his at Cramp's, a word or two may be said as to how they were conducted.

Here, for the first time, he had a lathe equipped with an electric drive "so as to obtain any desired cutting speed"; and when in 1912 he was testifying before the Special House Committee, he, to illustrate the fact that there is "no fear of overwork in the machine shop," went on to say:

Perhaps I can make it clearer to you by telling you that I worked the whole winter of 1895, I think it was, in running a machine myself. I went back and ran a machine for the whole winter in making a series of experiments in developing the "art of cutting metals," which I described to you in my direct testimony, and during this time I worked more steadily on that lathe than I had ever worked in my whole lifetime as a workman. I worked the same hours as the other workmen, and I tell you it was the easiest and happiest year I have had since I got out of my apprenticeship — that year of going back and working on a lathe. I worked hard from the machinist's standpoint and harder than I had ever worked before in my life as a mechanic. I was known to be a manager, and the men knew I was in there conducting some of the series of experiments that I have told you about on the art of cutting metals, and yet some of the men came to me and begged me not to set too fast a pace or the other fellows might have their rate cut as a result.

I give you my word, Mr. Chairman, that during that winter there was never a day that I was overworked, and I was physically soft; I was a comparatively middle-aged man and had not done any work by hand for twelve or fourteen years, and yet I was not in the slightest degree overworked.

While, of course, he did not work continuously at his experimental lathe during this winter, he did give many whole days to it as well as many whole hours; and here, surely, is monotonous work; on the saddle of the lathe you sit with the speed regulator in one hand and a stop watch in the other, and with your eyes riveted to the cutting tool — sit there hour after hour "like a mummy," as Barth describes it. Yet Taylor was happy in doing it. We take it that this was because his mind was at rest, that during these hours he could shake off responsibility and care. His, of course, was the type of mind that could find such a state of comparative lethargy attractive only temporarily; but this brings us to a fact that many of the critics of his management methods who themselves dwelt apart from industry failed, apparently, to take sufficiently into consideration, as when talking about making work interesting for workers, that at this period of the world there still are many thousands of men and women who are so worried and generally upset when called upon to depart from a fixed routine that the only thing you can do is to leave them to the routine or wean them away from it very gradually.

Among the notes he jotted down for a paper on experimenting, we find these:

> The true experimenter must be an enthusiast; he should have the keen delight in obtaining a result that the ordinary man would have in finding a diamond mine. This very enthusiasm, however, leads most experimenters into perhaps their worst error or fault, namely, with a desire to always get a positive, useful result, whereas perhaps nine out of ten experiments when truthfully carried out must lead to negative results or at least to doubtful results.
>
> This temptation is particularly strong when a time limit is set on the experiment. The true experimenter sets no time limit, but is willing to look forward for years and plod away.
>
> No fact should be accepted which cannot be verified by a second and third experiment. On the other hand, have faith that a result once obtained can be reduplicated.

He, of course, here had reference mainly to experimenting conducted at one's own expense. As he said in his autobiographic letter of 1910, he had as an engineer to keep his conscience "in very active service" to prevent him from devoting too much time to experimenting and "not enough to the less interesting but vital end of every-day management and economy." There is no reason to believe that his fine old New England conscience failed him at Cramp's; still, he must needs make his experiments thorough as far as they went, and this necessarily consumed time and was otherwise expensive. In his metal-cutting paper he "broadly defined the art of experimenting on this subject as an attempt to hold uniform and constant all of the elements which affect the final results under investigation except the one variable which is being studied, while this one is systematically changed and its effect upon the problem carefully noted." And then he added:

> It is the necessity of holding these variables constant which makes all these experiments so difficult, causes the apparatus and forgings tested to be so large and expensive, and consumes four-fifths of the time of the experimenter. Time and again in our work it has required days and sometimes weeks to prepare for an experiment which, after we have succeeded in obtaining uniformity in all the elements, has been made in a few days or hours.[1]

The outcome of his experiments at Cramp's to "determine the relative cutting speeds of the Mushet and the carbon tools" was two important discoveries he described as follows:

a That, comparing the self-hardening [Mushet] steel with carbon steel, a gain in speed of 41 per cent to 47 per cent could be made in cutting a hard forging of about the quality of tire steel; whereas a gain of nearly 90 per cent could be made in cutting the softer qualities of metal; and

b that by using a heavy stream of water on the nose of a Mushet or other self-hardening tool, a gain of about 30 per cent could be made in the cutting speed over the speeds possible when the same tools are run without water.

These experiments, then, indicated clearly that the use of Mushet steel almost exclusively for cutting exceedingly hard pieces of metal was the wrong one; since an enormously greater percentage of soft metal was cut in the average machine shop than of hard metal, and the gain in cutting soft metals was 90 per cent as against only a 45 per cent gain for hard. It thus became evident that instead of using self-hardening tools only occasionally for cutting extra hard pieces of metal, they should be used daily throughout the shop on all ordinary work in place of carbon steel tools.[2]

[1] *On the Art of Cutting Metals*, p. 86.
[2] *Ibid.*, p. 221.

It shows Taylor's loyalty to his employers that he prepared two reports to the Cramp Company on the outcome of his experiments, one report "to be shown promiscuously," and the other for the exclusive consideration of Edwin S. Cramp, the superintending engineer; the difference between them arising from the fact that in the "promiscuous" report Taylor disguised his discovery about self-hardening steel. "I regard it as of the highest importance for your concern," he wrote to Mr. Cramp, "that the exact considerations which govern your speeding up in the shop should only be known to yourself and as few of the members of your firm as practicable. Since if your employees, generally, know that the use of self-hardening steel plays such an important part in the increased output of your shop, it will not be long before this information will go to your competitors." Naturally he had to act on the principle that those whose sacrifice of time and money brings discoveries and inventions about should have all the benefit from being first in the field with them.

Evidently, however, his discovery about self-hardening steel did not long remain a secret; within five years, so we are told, from one-fourth to one-fifth of the roughing tools used in good machine shops had come to be made from this steel. Probably the Cramp people did not think enough of the discovery to take any pains to retain its exclusive benefit.

In connection with his discovery that a big gain in cutting speed can be made when a heavy stream of water is used on the nose of a self-hardening tool, it is interesting to note that, up to this time, makers of self-hardening steel had been in the habit of specifically warning users never to use water on these tools. Here, then, is an example of the results Taylor got by questioning the "most universally-accepted facts," as well as an example of how he found again and again that manufacturers had little or no idea of what could and should be done with their own machines or materials. And here, as related by him, is another and even more striking example of this latter fact:

> For many years it has been usual for salesmen of tool steels to give detailed accounts of the number of hours which tools made from their steels would cut metals without the necessity of regrinding. In fact, tool steel literature abounds in statements of the long life of tools with one grinding, implying that this is the proper standard for measuring their value. . . . For ninety-nine one-hundredths of the work of a shop, this criterion is of no value whatever, and the man who boasts of having run a tool without regrinding, say, for a longer period than one and one-half hours on ordinary shop work, is merely boasting of how little he knows about the art of cutting metals cheaply. . . .
>
> Briefly restated, the reason for this is that in order to have it last a long time, any given tool must be run at so slow a cutting speed as to waste the time of both the machinist and the machine. The small saving in grinder's wages, in the wages of the smith and in tool steel, which is made by having a tool last a very long time, is much more than overbalanced by the diminished output of the machine which corresponds with the slow cutting speed. So little, however, is the effect of the duration of the cut upon the cutting speed generally understood that probably not one machinist in a thousand realizes that there exist clearly defined laws as to the effect of the duration of the cut on the cutting speed. It is also safe to say that for the purpose of avoiding frequent grinding it is the almost universal practice in machine shops to run tools at cutting speeds which are entirely too slow for maximum economy, when all the elements bearing upon this subject are properly considered.[1]

Incidentally, this affords an example of the economic principles that Taylor had so much difficulty in getting his employers to comprehend. At Cramp's, apparently, all they could see in it was that he wanted to run up their bills for tool steel and add grinders and smiths to the pay roll.

Now comes something very interesting. After he had dis-

[1] *Ibid.*, beginning on p. 73 and continued on p. 189.

covered the value of self-hardening steel for all kinds of roughing work, he was confronted by the fact that there were on the market various makes of self-hardening steel, each differing more or less in its chemical composition. Which make was, on the whole, the best? Which should be adopted for the shop standard?

With the consent of the Cramp people, Taylor took this question to his former chief, William Sellers, who, it will be remembered, had long ceased to have any part in the management of Midvale, and Sellers agreed to bear part of the expense of the experimenting needed to settle it. Thus at the joint expense of the Cramp Company and William Sellers & Company, these experiments were conducted by Taylor early in 1895 at the Sellers shop.

As a result of this work [said Taylor] the choice was narrowed down at that time to two makes of tool steels: (1) the celebrated Mushet self-hardening steel, . . . and (2) a self-hardening steel made by the Midvale Steel Company. . . . Of these two steels, the tools made from the Midvale steel were shown to be capable of running at rather higher cutting speeds. The writer himself heated hundreds of tools of these makes in the course of his experiments in order to accurately determine the best temperatures for forging and heating them prior to grinding so as to get the best cutting speeds. In these experiments he found that the Mushet steel if overheated crumbled badly when struck even a light blow on the anvil, while the Midvale steel if overheated showed no tendency to crumble, but, on the other hand, was apparently permanently injured. In fact, heating these tools slightly beyond a bright cherry red caused them to permanently fall down in their cutting speeds; and the writer was unable at that time to find any subsequent heat treatment which would restore a tool broken down in this way to its original good condition. This defect in the Midvale tools left us in doubt as to whether the Mushet or the Midvale was, on the whole, the better to adopt as a shop standard.[1]

[1] *Ibid.*, p. 50.

On the verge he then was of the sensational discovery that led to high-speed steel; namely, the discovery of the wonderful property of "red hardness" that is imparted to self-hardening steel through a paradoxical kind of heat treatment. For the time being, however, he could not go on with these experiments. And this was because of the attitude of the Cramp people.

Wherever scientific methods are introduced, he wrote in *Shop Management*,[1] those who direct the company "should be prepared to lose some of their valuable men who cannot stand the change, and also for the continued indignant protest of many of their old and trusted employees who can see nothing but extravagance in the new ways, and ruin ahead." No amount of opposition could break down his own purpose; but when spring came and he made his report on all he had done and what further should be done, the owners of the business decided they had had enough. His view of it was that as those owners were financiers they had no real interest in the development of the shop. The owners' view evidently was the reflection of the view taken by the operating chiefs. It is certain that when, many years later, the controversy arose over the introduction of Taylor methods into the navy yards, Cramp's shipyards were the source of reports that these methods would bankrupt the government. And it became a common thing for Taylor's opponents to charge that his system, after being tried at Cramp's, had been thrown out.

What there was in this latter statement will appear when we examine the report, dated March 12, 1895, which Taylor made to Edwin S. Cramp. Incidental to recommending the changes which should be made in the speed of the machines, he stated that the following "alterations in the various details" of the shops had been made by him:

[1] p. 130.

1st. Special furnaces and a steam hammer have been introduced in your smith shop for dressing and tempering machine shop tools; and all of your tool dressing has been concentrated in one part of your works, thus enabling it to be done much more systematically and better, as well as cheaper.

2nd. Special grinding machinery has been introduced for grinding automatically, in large quantities, all chippers' and drillers' tools, as well as all machine shop tools.

3rd. Tool rooms have been planned and partly completed, from which tools already ground to exactly their proper shapes, can be issued to all of the machinists throughout your machine shops, in lots of sufficient quantities, so that a machinist who has gone to work on a job which will last him several hours will be able to proceed continuously with the running of his machine, without having to grind a single tool himself, and without the necessity of returning to the tool room for a new set of tools until after his job is finished.

4th. The writer is about to proceed to make a model of each shape of standard tools, a supply of which should be kept on hand for all the machines throughout the place. After these models have been made, and carefully considered with a view to cheap dressing and grinding, and, at the same time, so shaping them as to be able to run the machines at the highest practicable cutting speeds, these tools should be made in large quantities and then issued, as above stated, in batches from the tool rooms to the men.

5th. The writer has just completed a series of experiments to determine the best makes of tool steel to use, and he believes it to be economical to adopt the very best tool steel that can be had for each class of work which is done in the shop, the first cost of the steel being of comparatively small importance, providing the steel obtained, in all cases, shall be the best of its kind, and uniform and reliable.

6th. The details of a system for ordering, installing and then properly caring for all belts throughout your establishment, at regular intervals, has been written out by the writer. If this system is adopted and properly carried out, every machine in your place should be in condition at all times to drive up to its maximum capacity, and none of your machines should practically ever be stopped during working hours for tightening your belts, and your belting would last three or four times as long as it does at present and cost much less for its maintenance.

It is clear from this that while in his short time at Cramp's he laid the foundations for many valuable economies, he, so far as the introduction of his *system* was concerned, hardly got started. Altogether he was at Cramp's six months. What happens when the Taylor System really is introduced anywhere may be gathered from this extract from the testimony given in 1911 before the Special House Committee by Henry R. Towne:

> It took us, in the two departments where we have installed it [the Taylor system], nearly three years to get it effectively into operation, and cost us about $25,000 in cash outlay before we began to get anything back, but we have recouped that many times over by the resulting benefits. . . . If I had followed the judgment and shared the fears of my junior associates at the end of the first year of our work in the installation of the Taylor system, we would have abandoned it and thrown it out; but I fortunately had not only faith in the ultimate outcome, but I had experience behind it which led me to realize that at that stage we were in no position to judge of the final result.

That at Cramp's no one even began to catch the spirit of Taylor's methods, and that in consequence no attempt ever was made to practice even those he was able to introduce — this clearly appears in a letter from an engineer who in June, 1895, only a few months after Taylor left there, went to work in the Cramp shops as an apprentice to a journeyman machinist. Though we are not at liberty to print this engineer's name, we can vouch for his entire responsibility, and if we quote at length, it is because of the vivid picture he draws of the "system" that was the very negation of Taylor's:

> The management at Cramp's made a great fetish in those days of having everybody within the gates when the whistles blew. But once

we were inside the gate there was almost no attention paid to individual achievement. There certainly was no organized method of controlling it. A system under which every journeyman working in the shop was assisted by *two* helpers irrespective of the character of the job — this was a generally recognized abuse of those days. It is a physical impossibility to keep awake under such circumstances, much less to be productive.

Along in the latter part of October, 1895, we noticed a large number of new faces among the workmen. Our interest was especially aroused when they began cleaning the windows of the blacksmith shop. When a few days later these strangers disappeared as mysteriously as they came, it developed that through providing "jobs" just prior to Election Day for some of the first families of Fishtown, the Republican majority had been increased. Long live the tariff and protection to our infant industries!

I was associated in the work of the shop with a mechanic having a specialty. Nobody ever came under the orders of a kinder or more sympathetic boss. But he knew the "system." He knew that if we ran out of the particular kind of work on which he was engaged and on which he was an expert, we both would be laid off. So if he could not see a month's work ahead providing a reasonable factor of safety, we did not slow up — we *stopped.* I can hear him now in stentorian but semi-humorous tones telling me to "take that pipe and go as far as you can in that direction (pointing out across the yard), and then come back." When this occurred on Monday morning, I knew that the estimate of work ahead had been decided against us and that this was a week in which we would do nothing.

My boss, having a couple of beers with his lunch, would often get drowsy after this meal and lie down for a little snooze. The only place completely out of sight was the low-pressure cylinder of one of the battleship engines erected in this shop. When a snooze was scheduled, my job was to surreptitiously gather enough burlap to make a reasonably soft bed for my industrial lord and master. As a rule I sat on the opposite side of the cylinder during these naps, keeping watch and out of sight at the same time. On waking up, my good friend would sometimes while away the rest of the afternoon with song and story. As he had been on the stage, this was no mean performance. The man who drove the travelling crane was likely to pass over us during the afternoon; so on Friday evening (pay day), on the way home, he was my boss's guest at one of the gilded drink parlors " up the Avenue."

We had one big boss; *i.e.*, the foreman of the shop. The lapse of twenty years has not effaced the memory of his thoughtful, tired and careworn face. Nobody loved him, but we had a certain respect for a man who could keep this big shop going as well as he did with no assistance of any kind. Of course the problem of the individual worker was to keep this man's favor and yet not allow him to dictate output. In assigning work and saying when it was wanted, he was careful not to be too specific. This had a double purpose: (1) to cover his own ignorance of the time it should take, and (2) to imply a certain confidence in the men.

Our superintendent was looked upon altogether as a joke. He liked " lots doing " and was " hell on noise." In other words, he was of the opinion that a bustling, noisy shop is necessarily a profitable shop. So we apprentices had our orders to make a racket whenever he approached. I usually kept a piece of sheet iron handy for such occasions.

I had not been two months in the shop before I began not only choosing my own tools from the miscellaneous stock in the tool room, but grinding them to my own uneducated fancy. The bolts, nuts, clamps, etc., used for setting up work in machine tools were kept in great disorder in boxes under the work benches. It not infrequently took hours to gather the necessary equipment for one single set-up. As I realize how all these details are carefully prescribed and controlled under the Taylor system, two queries present themselves: (1) how did we ever get anything done at Cramp's in 1895? and (2) how much of the new order has permeated this organization in the intervening years?

It is highly probable that, encountering here one of the worst cases of traditionalism that the times afforded, Taylor conspicuously failed to refrain from attempting to push men along too fast on the road of science, and that he needlessly antagonized them by his habit of being too anticipative of opposition and therefore of assuming a manner too aggressive, imperious, and belligerent. At the same time there can be little doubt that even if he had set out to introduce scientific methods there with the perfection of caution, tact, and diplomacy, a general disturbance among the officials would have been bound to come as they were called upon to give up their individual or rule-of-thumb methods. In those days it was inevitable that the owner of an establishment run in the old way should have to pay a price for scientific economy not only in money but in trouble. And in the case of the financial gentlemen who in the 1890's controlled Cramp's, it is quite easy to understand why they should have balked at the price, seeing that they dealt mainly with a protecting government which willingly paid them prices that more than absorbed the cost of any lack of economy.

That Taylor did not escape from Cramp's with spirit unwounded, is certain. But it should go without saying that it is not only on the battlefield that men have an opportunity to forget their wounds and carry on.

CHAPTER IX

VARIOUS WORK FOR VARIOUS CLIENTS

IN the case of none of the firms by which he was employed as a consultant were the circumstances such as to make it possible for him to work out a complete development of his system. The methods and mechanisms which he later linked together were developed here and there as special occasion for them arose.

His work for William Deering & Company (later called the Deering Harvester Company) was begun, if not finished, before he went to Cramp's, and consisted mainly of reorganizing the company's financial, credit, and sales-agency methods. The Northern Electrical Manufacturing Company, of Madison, Wisconsin, for which he did work in 1896, was a new concern whose product consisted mainly of motors and dynamos. If only because it made slow progress in those hard times, he could not there go very far in introducing his methods.

More extensive and certainly much more significant was the work he did, also in 1896, for the Lorain Steel Company and its allied concern, the Johnson Company. Later a subsidiary of the United States Steel Corporation, the Lorain Company then had for its general manager Coleman du Pont, of the Delaware du Pont family which later became widely known for the activities of its members as powder manufacturers. It was Coleman du Pont who, having read *A Piece-Rate System,* employed Taylor. At first Taylor's activities were confined to reorganizing what was known as the Steel Motor Works, a plant in Johnstown, Pennsylvania, which was operated by the Johnson Company and built motors for electric cars for the Lorain Company. Later his methods were applied by him to the other branches of this general steel business, and Mr. du Pont writes us that all his work was "well worth while."

It will be recalled that his first work for the Simonds Rolling Machine Company, which he began in the fall of 1893 and continued with until well into 1894, was largely confined to the accounting end. This was true also of his work for the Northern Electrical Company, the Johnson Company, and the Lorain Company; and the documents he preserved reveal that, dating from the summer of 1893, when he began to give the subject of accounting special study, he made steady progress in the development of a comprehensive method of analyzing and classifying expenses and of distributing the overhead on to the product, this directed to the general end of preparing monthly reports showing every cent that had been spent during the previous month and what was obtained for it.[1] Inevitably this made necessary a system of symbols for designating departments and their activities (overhead account), raw or purchased materials or stores, worked materials, and stock (product account), and plant, real estate, machinery, tools, and so on (asset or construction account). And in the case of a man like Taylor this, in turn, inevitably led to the development of mechanism for the *control* of activities, materials, and so on.

In his work for the Simonds plant appeared the first indication of his *mnemonic* classification of accounts. Here also appeared the first indication of his "expense distribution sheet" (to get distribution of overhead expenses on to production of the month), and the first indication of his worked

[1] At the Simonds plant, Taylor's "Exhibit A" was his "Expense Analysis Sheet," and it was followed by sheets giving in detail the cost of the work finished during the month. "Exhibit B" was the "Income Accounts Statement." In presenting his analyses, he always adopted the regressive method; that is, gave you the results *at the top*. If the statement of these results did not satisfy you, although they very well might, you then could proceed to the details of how they were reached.

✓ 24840

lor, F. W.

Copley

DATE	ISSUED TO
22 49	Handy, David X
16 49	[illegible]
24 49	"
1 49	[illegible]
5 49	"
15 49	[illegible]
22 49	" "
22 49	
JAN 30 1950	Carlson, Ra[illegible] W.
OCT 13 1950	[illegible]
DEC 31 1950	Mr. [illegible]

131

July 21, 1894.

Dear Sirs:--

About September 1, 1894, we shall make a contract for not less than 2250 reams of Cream Tint, Sized and Super-calendered Book Paper for our annual catalogue. We shall want the privilege of increasing this order on or before December 1st to not more than 2700 reams.

The conditions of this contract will be as follows:

WEIGHT. The weight of the paper will be on the basis of 33 x 41 - 90 lbs. to 500 sheets. We desire that all bids shall be made on the basis of full count and full weight, without allowance for wrappers, crates, cases, frames or strings; in other words, that each 500 sheets must weigh 90 lbs. and no allowance will be made for over-weight; test for weights to be arrived at by weighing ten per cent of the parcels taken at random.

QUALITY. The quality of the paper to be better in every respect than the printed sample attached hereto. The quality of the paper to be such as is suitable for printing half tone cuts in a satisfactory manner to us. It is understood that the paper shall be uniform in color, cleanliness and finish.

COLOR. The color of the paper shall be Cream Tint.

TIME OF MAKING. It is distinctly understood that the mill taking the order will begin making the paper as soon as the order is placed, and that it will run it continuously on one paper machine, without putting on other orders, until the amount called for is finished.

DELIVERY. It is understood that the paper is to be delivered at such places in the City of Chicago as we shall specify hereafter.

TIME OF DELIVERY. Deliveries are to begin on or about December 1st, and are to be made as rapidly and in such quantities as we shall hereafter direct. It is understood that we will take all the paper by February 1, 1895.

PIONEER PURCHASING BY SPECIFICATION

A method of purchasing to which Taylor early was led by his principle of standardization. Chicago, 1894

A manufacturing concern in this city amuses the trade very much over the extreme care exercised in buying an ordinary bill of paper. While the order may be a little larger than the every day occurrence, it is not much compared with some any of the paper houses in the city are handling now or a little earlier in the season. The amusing part and the only thing to attract attention is, that the concern sends out a long list of specifications in paragraphs and many of them and invites prices probably from all the paper houses found in the directories. The estimates are usually sent in in the usual way; then in a few days printed, postal cards are sent out by the concern, probably a great many, which say, "We thank you for quotations on,——— but are unable to make use of it." But comments are unnecessary. After all it is rather nice for the business man to be relieved occasionally by a little ripple of mirth.

RIDICULING THE NEW

A trade paper's response to purchasing by specification in 1894 materials cost sheet. And here too appeared the first specimen of his famous balance of stores sheet, but without the "available" column, which was not added until the introduction of his methods at the Link-Belt plant. For the control of stores and worked materials and the prevention of their waste, he worked out at the Simonds plant his first purchase requisition, with column for stores-tag number (here was the first indication of the up-to-date stores tag), and here also appeared his first stores issue slips, worked materials delivered slips, and worked materials issue slips.

Such things as the immediately foregoing are mentioned mainly to indicate something of the thoroughness or attention to detail that Taylor put into everything he essayed. Because of its broadly social import, everyone should be interested in that feature of his accounting work for the Simonds Company which had to do with the introduction of a record of "machine dollar hours." Back of this record lay a method of determining the hourly cost or "wages" of each machine (the method is too complicated for exposition here), and the general object was to show what each machine earned or the extent to which it was utilized. The general idea of this Taylor got from the Sellers Company, and he applied it, with important modifications of his own, to the machine shop, smith shop, and rolling machines at the Simonds plant. Such a record plainly directs attention to the cost of maintaining idle machinery. Later on, when Henry L. Gantt, at Taylor's instigation, came to be employed by the Simonds Company, he was deeply impressed by this, and it was destined to bear fruit many years later in the vigorous attacks Gantt made against the practice of including the expense of idle plant in production costs.[1]

[1] As he defined it in a paper presented at the A.S.M.E in December, 1916, Gantt's principle was that "the cost of an article should include only those expenses actually needed for its production, and any other expenses incurred by the producers for any reason whatever must be charged to some other account" and "deducted from the profits."

Though Taylor in this period placed a higher relative importance upon accounting than he did later, it is obvious, from the mechanism he devised for the Simonds Company, that his attitude towards it was from the beginning that of the engineer rather than that of the professional accountant of these latter days. That is to say, he was not so much interested in showing what *had* been done as in what *was* being done and especially in what *should* be done. From the beginning he moved in the direction of making the accounting a part of the control, and further evidence of this is afforded by the time card he devised for the Simonds Company. Here, evidently, was the first appearance of this card which, serving the ends both of control and of production and cost records, is now such a conspicuous feature of the mechanism of Taylorism. It is true that the Simonds card was a very crude one, but the rudiments of the modern article were there.[1]

It was at the Steel Motor Works, in 1896, that Taylor devised the first example of a complete classification of accounts, with mnemonic symbols arranged in the manner still adhered to; namely, that of devoting the first letters of the alphabet to the overhead expense account, the middle letters to the product account, and the last letters to the asset or construction account.

The chief significance of his work at this latter plant lies in the fact that here, for the first time when he had an opportunity to do something resembling thorough work as a management engineer, he was confronted by a complex product, or one made up of a number of differing parts. That he promptly arose to the situation is shown by his papers and documents. Here he made his first attempt at stores classification with mnemonic symbols; here was the first example of the group issuing of stores and worked materials for as-

[1] It had two checking squares, one headed "Time Sheet" and the other "Cost Sheet."

sembling purposes; and here he devised his first "route" or assembling chart, or one designed to show how all the parts were brought together to build the motor up.

The general situation he encountered at the Steel Motor Works is indicated in a letter he wrote in Johnstown in October, 1896, to the manager of the Northern Electrical Company, whose product was similar to that of the Steel Motor Works.

I hope [he said] that you are beginning now to climb out of your various troubles. I do not of course anticipate that your works are at all busy, for my impression is that the whole country is now at a standstill, but I hope that when the times brisk up after election you will be in a position to spread out in your business.

The Johnson Company here is almost prostrated for lack of work, but fortunately for me the good effects of the system of cheapening costs became evident before this absolute stagnation of business came on, so that I have been kept here even when nothing is doing to improve methods still further. We have met with very great success in reducing the cost of manufacture. When I came to the motor works the whole of their shop work was practically done on the contract system. They had some twenty or thirty contractors who agreed to make the various parts of their motors for a fixed price. I immediately started to turn the work from the contract to the detailed piece work system under which a separate price is given for each small operation and this system has already reduced costs enormously. In the classes of work to which it has been applied the cost has been fully cut in half. We have saved enough in the wages of armature winding alone to pay for all the cost of introducing the system and running it.

In closing his letter, Taylor said: "I hope that you will for some time to come, at any rate, confine your business to as few types of motors as possible. I feel sure you will make more money this way than by spreading out into a great variety of work." Very early in his career he preached the advantages of specializing in a few standardized products, and in his later years he often pointed to the success of Henry Ford's car as an example of this.

A letter he addressed in October, 1896, to T. C. du Pont, the general manager of the Johnson Company, gives an interesting view of what he aimed at in the management of clerical work.

I beg leave [he wrote] to suggest the following rules for regulating the work of the clerks in the Auditing Department:

1. That the hours of work shall be from eight o'clock A.M. until five o'clock P.M.

2. No talking above a whisper during working hours.

3. A special room or section for calling off figures from one book to another, and never more than two men to be in this room at the same time.

4. No smoking during working hours.

5. The duties of each man who works on the routine part of the bookkeeping to be clearly defined and as far as is possible the work which belongs to one day to be entirely separated from that which belongs to the day following.

6. Each clerk shall be allowed to go home any time during the day when his work is done.

7. Each man must finish his work properly belonging to that day, even if he has to stay all night to do it.

8. Each man must register in a special book for the purpose the exact hour and minute of his arrival and departure, morning, noon and night. (A Bundy time clock might be used instead of a book for registering.)

My reason for suggesting the above rules is that I think the average clerk cannot work hard and faithfully for a longer time than from 8 o'clock until 4:30 or 5 o'clock, and I believe that much more work can be accomplished by having men work at their best while they are in the office and then giving them all extra time for recreation rather than have them intersperse their recreation with their work, as they are now doing.

No one subscribed more heartily than Taylor to the principle that everything possible should be done to make work interesting. And it is to be observed that in setting definite tasks for workers, as he would have done in the case of those clerks also, he did make work more interesting by breaking up the monotony of routine work and repeat operations.[1] But he made a real distinction between interest and amusement, and in his philosophy life in general was such a stern business that he could not believe that anyone, not even a workman, could be made fit for it by leading him to think that it was for him to deal only with such things as might pleasantly engage and occupy his attention. His idea, as shown in the rules he proposed for the Johnson Company's clerks, was to keep work and amusement separate, and by working when you worked have more time to play when you played. Undoubtedly his suggestion that those clerks be permitted to go home when they had finished the daily tasks he proposed for them was found nothing less than sensational. For himself, however, he never could see that anyone was paid just to "stick around," and it was shocking to his economic, not to say moral, sense that people should be required to go through motions just to fill in time or for any purpose other than that of bringing about a useful result. And on this general subject there will be more a little later.

Now, it was in November of 1896 that the leading men of the Simonds Company, having became dissatisfied with the general manager of their works in Fitchburg, asked Taylor to confer with them as to what should be done, and it will be recalled that, as a condition to giving them the benefit of his knowledge and experience, he demanded that he be placed

[1] There, for example, is all the difference in the world between telling a man to spend a day bringing water from a river and telling him to bring up a certain number of bucketsful. In the latter case, his mind has got something definite to work on, and this is especially true when he knows he can quit as soon as he finishes his stint.

in sole control of the shop until April, 1898. We have seen also that he had acquired some stock in this company in return for patent rights. Thus back of his demand that the control of the shop be surrendered to him was the fact that, nothing daunted by his previous experiences, he saw here another promising opportunity, not only to demonstrate the value of his methods, but also to build up his own personal fortunes. Manufacturing balls for bicycle bearings, the Simonds Company did seem to have a fine future, especially with the quietus given to the free-silver agitation early that month by Bryan's defeat for the Presidency. The craze that set in when bicycles of the "safety" type replaced the old high-wheel type was in these years attaining its climax. There was scarcely a city that did not have its bicycle club, and many of the larger cities had gone to great expense in laying out special bicycle paths in connection with their park and parkway systems. It looked as if every man, women, and child was taking to the wheel, and apparently it did not occur to anyone that this sort of thing was not to continue more or less indefinitely.

When, early in December, the directors of the Simonds Company formally resolved to give Taylor the control of the shop he asked, he and his wife rented an apartment for the winter in Boston, from which city he made daily trips to Fitchburg. In the Boston vicinity he had numerous kinspeople on his mother's side, and it was his pleasure to see them frequently. He was as genial a visitor as he was a host. And he was a boon companion on a trip; the ridiculous side never escaped him, and few were the things in which he could not find something humorous. All this time, in fact, we must picture him as leading a unique kind of "double life." His working hours were full of toil and trouble. His domestic and social hours were happy and blithesome and gay. If in the workaday world he dramatized himself as a terror, he in his social world dramatized himself as one of the gentlest and most Chesterfieldian of beings.

On July 4, 1896, while living in Johnstown, he played golf for the first time, and now at the beginning of the summer of 1897, when he and his wife went to live in Fitchburg, he took to playing this game after 4 o'clock in the afternoon as a regular thing, despite the criticism it drew upon him.

The fact is that he had adopted for himself a new working policy, and to this he continued invariably to stick, no matter who liked it or who didn't. He was through with working overtime, feeling that he had done his full share of it. He had come to see that he best could serve by refraining entirely from doing things himself, and concentrating on the visioning, the thinking out, the planning, the general direction. And as he did this, he naturally had to reduce his working hours. Thinking, in the degree that it is done in the abstract, is the most exhausting form of labor, but this is more than made up for by the fact that five minutes thinking may add more wealth to the world than could be produced in years of manual labor. Barth tells us that when he went to work at Bethlehem, he made the mistake of asking Taylor what his hours were to be. It was a mistake, seeing that it permitted Taylor to retort: "I don't care whether you work or not, as long as you produce results." He always was amused by those managers who put such stress on the *time* a man works; who appear to think, as they did at Cramp's, that the art of management mainly consists in getting all the men within the gates at a certain hour and seeing that none leave until a certain hour.

It is clear now that the new working policy he adopted and the golf playing he took to in Fitchburg were practically enforced upon him. It undoubtedly was as true of him in these years as it was in his later that his mind, as his physician expressed it, was so preoccupied with other things that his body found it difficult to register such sensations as those of fatigue. But at Fitchburg symptoms of a weakened nervous system, mainly in the form of dyspepsia and insomnia, began to manifest themselves to him too insistently for him to disregard entirely. Writing in 1913 to his friend, Scudder Klyce, then a naval constructor, he said:

> Let me repeat that the one thing in your letter which gives me the very greatest pleasure is the fact that you are improving in health. I wish that you would take the warning and advice of a man who has suffered greatly from his early blunders, and deliberately take a whole lot of time for some form of very simple mental relaxation. I am now suffering, and have been for several years, because when I was younger I thought I was made of iron and used up my nervous energy and strength too fast. But I hope that I am now in a fair way to attain the proper balance between mental work and some form of out-of-door physical exercise and relaxation, so that I shall not grow any worse.
>
> For me, however, I find it many times exceedingly irksome to give up the intellectual work in which I am at the time very greatly interested, and go out onto a dreary golf links to spend two or three hours chasing after a golf ball. For me this medicine is frequently as bad as to go to the dentist; and yet when I once get out on the links and begin my exercise in the open air, somehow I lose my disgust and begin to cheer up and profit by the complete physical and mental change. Personally, I feel as if I need a guardian a good deal of the time, to lay out my day's work for me and keep me from doing too much of the nerve-racking kind.

It would seem that the best of us are in need of some kind of external control, but it was extremely difficult to realize this in the case of Frederick Taylor. It was not merely that he habitually kept all his troubles to himself. He was such a self-reliant man that it seemed all but incredible that he ever should be in need of help. So accustomed did you become to seeing him doing things for others that you naturally fell into the habit of thinking there was scarcely anything that anyone could do for him.

Though he suffered from dyspepsia at Fitchburg, it did not lessen the enthusiasm with which he took up the work of reorganizing the Simonds shop. And it shows what confidence he had in his own methods that no sooner was he placed in control of the shop than he set about promoting the company's finances, taking additional stock himself and getting several of his friends and relatives to subscribe. Again he was doomed to disappointment as regards the financial end, but again as regards the operating end he, coping with conditions new to his experience, had brilliant success.

CHAPTER X

IN THE SIMONDS SHOP

IN December, 1896, Alfred Bowditch, president of the Simonds Company, wrote the general manager of the works to inform him that he was relieved from responsibility for the shop, " Mr. Fred W. Taylor " having been granted " entire and absolute authority over the same." Needless to say, this news was not received by the general manager with enthusiasm. Apparently he at once set about trying to balk the man who had displaced him in the control of the shop; and it was due to his machinations that, in the fall of 1897, Walter A. Simonds, principal owner of the business, wrote to Taylor's former employers. Here, as contained in a letter to Mr. Harrah of Midvale, is Taylor's explanation of the trouble:

On the 28th of June [1897] he [the general manager] resigned on three days' notice, and with him every foreman and assistant foreman in the place, as well as the superintendent, all of the salesmen, and the head man in the office. This was the first that the directors or anyone connected with the company knew of their intentions. They did this, of course, hoping to put the Simonds Co. into such a hole that they would be obliged to shut down or else, as ——— hoped, discharge me and go back to the old system of management. There was, however, only one of the nine directors beside ——— himself who considered any such course as this for five minutes, and ——— was the most disappointed man in Fitchburg when we found the exact sentiment of the directors.

His new concern is a grand failure, and at the stockholders' meeting of the Simonds Co. which occurred about three weeks ago he appeared and wanted to patch up the breach and come back again, but the same Board of Directors was chosen, and my management was entirely endorsed by them.

Owing to the severe competition in the bicycle ball business, however, the price of balls has fallen to one-half what it was last season, and this of course stops the payment of dividends. Young Mr. Simonds naturally wants dividends, and ——— has told him, as he has everyone else connected with the company, that if he were only managing the company now they would be paying just as large dividends as ever.

He has also spread no end of lies broadcast about me, saying that I never have made a success of anything, that I had always been fired wherever I have been, that I had no friends, and was a very general kind of a damned fool.

Prior to December, 1896, when Taylor took hold, the works had been shut down for many weeks to permit of the resetting of the machinery in the new building that just had been erected. Thus it was feared that the company would not have enough balls to meet the requirements of its customers during the season of 1897, and Taylor was urged to rush production.

With this as his prime object, he first turned his attention to those departments which, being the slowest, had been limiting the output. The slowest of all was the department where the balls were rough ground, and the next slowest was that where the finish grinding was done.. The men in these, as well as the men and girls in all the other departments, had all along been employed on a day-work basis. By March, 1897, Taylor had put the two slowest departments on piece work. The result was that, with the same number of men working the same hours with the same machinery, the production was increased from an average of 5,000,000 balls a month to 17,000,000. And at the same time a better quality of ball was insured through a much more rigid system of inspection.

Probably it was the general manager's envy of this success that precipitated his action in June; but while his resignation, along with that of practically all the other head men in shop and office, was embarrassing, it ultimately was of advantage to Taylor, in that it gave him a clear field for the introduction of his methods. In fact, it enabled him to get installed in the office of general manager a man who, besides being specially qualified for such a position, was above all others at the time best able to understand his methods; this being his old Midvale associate, Henry L. Gantt.

Now, when Taylor had time to analyze all of the twenty or more operations incidental to the manufacture of those small steel balls, he concluded that the most important probably was that of inspecting them after their final polishing. Engaged in this work were about 120 girls, all of whom were "old hands" and supposed to be skilled. They worked ten and a half hours a day, with a Saturday half holiday, or fifty-eight hours a week, the full limit permitted by law.

> Their work [said Taylor] consisted briefly in placing a row of small polished balls on the back of the left hand, in the crease between two of the fingers pressed together, and while they were rolled over and over, they were minutely examined in a strong light, and with the aid of a magnet held in the right hand, the defective balls were picked out and thrown into especial boxes. Four kinds of defects were looked for — dented, soft, scratched, and fire-cracked — and they were mostly so minute as to be invisible to an eye not especially trained to this work. It required the closest attention and concentration, so that the nervous tension of the inspectors was considerable, in spite of the fact that they were comfortably seated and were not physically tired.[1]

As he said in a report made to the company, the problem of systemizing this inspection work proved for some time a

[1] *Principles of Scientific Management*, p. 87.

"stumbling block." Approaching it very cautiously, he eventually employed Sanford E. Thompson to help him with it, and again we read:

> A most casual study made it evident that a very considerable part of the ten and one-half hours during which the girls were supposed to work was really spent in idleness because the working period was too long.
>
> It is a matter of ordinary common sense to plan working hours so that the workers can really "work while they work" and "play while they play," and not mix the two.
>
> Before the arrival of Mr. Sanford E. Thompson, who undertook a scientific study of the whole process, we decided, therefore, to shorten the working hours.
>
> The old foreman who had been over the inspecting room for years was instructed to interview one after another of the better inspectors and more influential girls and persuade them that they could do just as much work in ten hours each day as they had been doing in ten and one-half hours. Each girl was told that the proposition was to shorten the day's work to ten hours and pay the same day's pay they were receiving for the ten and one-half hours.
>
> In about two weeks the foreman reported that all of the girls he had talked to agreed that they could do their present work just as well in ten hours as in ten and one-half and that they approved of the change.
>
> The writer had not been especially noted for his tact, so he decided that it would be wise for him to display a little more of this quality by having the girls vote on the proposition. This decision was hardly justified, however, for when the vote was taken the girls were unanimous that ten and one-half hours was good enough for them and they wanted no innovation of any kind.[1]

Of course those girls did not object to the proposition of reduced hours in itself; they feared that this innovation would be but the prelude to others, and were of the opinion that they would better stick to the evils they knew of than open

[1] *Ibid.*, p. 87.

the door to the unfamiliar. Their vote, so we read, settled the matter for the time being, but "a few months later tact was thrown to the winds and the working hours were arbitrarily shortened in successive steps to 10 hours, $9\frac{1}{2}$, 9, and $8\frac{1}{2}$ (the pay per day remaining the same); and with each shortening of the working day the output increased instead of diminished." [1]

That Taylor did not mean that the increase of output was entirely in consequence of the shortening of the hours, will be seen from the reply he made to Miss Josephine Goldmark, of the National Consumers' League, when in 1912 she wrote to tell him that she was "in search of data showing the effects of diminishing the hours of labor in industrial establishments upon output and the efficiency of the workers."

> I am very sure [said Taylor] that in many trades, particularly those which require very close attention, there would be an increase in the output down to say 8, or even perhaps $7\frac{1}{2}$ hours per day, provided no other element than this came in.
>
> Unfortunately for your immediate case, however, in all the cases with which we have had to deal with shortening the hours, there are many other elements mixed in, so that while there has invariably been an increase in output with the shorter hours, it is very difficult to prove to what extent it is due to shorter hours and to what extent other causes are accompanying the shorter hours.
>
> I would refer you to my book, "The Principles of Scientific Management," page 86, etc. [The part dealing with the work of the Simonds girls.] In this case, however, a large part of the improvement was due to the scientific selection of the girls, rather than to the shortening of the hours. There is, however, no question whatever that in this case merely shortening the hours also produced an increase in output.

Besides being scientifically selected, these girls were put on piece work, and other changes were made such as giving them

[1] *Ibid.*, p. 88.

a morning and an afternoon recess. The part played in the increased output by the shortened hours, as distinguished from the part played by these other things, is undoubtedly indicated as closely as it can be by Sanford E. Thompson, who handled the detail pertaining to the systemizing of these girls' work.

It was on the first of August [writes Thompson] that the hours were reduced from 10½ to 9½. At the same time a recess of five minutes was allowed in the middle of the forenoon and again in the afternoon, while the Saturday half holiday was continued. During August the girls turned out 33% more work than during July; that is, they did one-third more in 9½ hours than they had done in 10½. Piece work was in operation during both months, but it is probably not fair to claim that the entire amount of increase was due to the reduction in hours. Although the girls had been working for years on this class of work, the fact that they were obtaining credit in real hard cash for extra efforts put forth, made them more expert. Part of the increase in product is probably therefore due to the extra ability of the girls.

At the end of August, things were working very smoothly, and the next change in the quantity of balls handled may be said to be due almost entirely to the reduction in hours. The first of September the working day was shortened to 8½ hours, the morning and afternoon recesses were increased to ten minutes, and the Saturday half holiday was maintained. During the month of September the amount of labor as shown by the finished product was almost exactly the same for each girl as during the month of August, although they worked one hour per day less. To express it in exact figures, the girls in 8½ hours did one-twelth of one per cent more work per day than they had done previously in 9½ hours.

Although the girls worked much faster after the introduction of piece work and the shortening of the hours, they also did more thorough work. This was shown by very careful experiments made upon balls inspected and boxed under the two different systems. The means used to maintain the quality were very careful over-inspection and the method of basing the rate of pay upon the quality of the work.

Under the shorter hours, although they did more work, the girls appeared less tired. They worked steadily, instead of stopping frequently to rest or to speak to their neighbors.

In closing, Thompson says:

The question of course arises whether a still further reduction in the hours could have been made with the result of still maintaining the same volume of product per day. The fact that there was practically no increase in the volume of work after the change from $9\frac{1}{2}$ hours to $8\frac{1}{2}$ hours, coupled with the fact that under the latter conditions the girls were working very steadily, would tend to show that in this particular class of work the point of maximum production had been reached.

I do not pretend to say that the results described prove that $8\frac{1}{2}$ hours is the exact length of day which should be adopted in all classes of labor. It is not too much to claim, however, that in a vast number of cases, especially in industrial establishments, the length of day might be shortened to the advantage of both the workman and the capitalist, provided that some incentive be given to the worker, such as the assurance, if he is a piece worker, that his rate per piece will not be cut if he exerts himself.[1] Even where machinery is employed, the product of the machine generally depends upon the ability, or more often upon the swiftness of the operator. Almost always there is a large amount of wasted time between operations which can be used to advantage. Often the machine itself may be improved so as to run with no breakdowns or stoppages.

The length of day should undoubtedly vary with the character of the work. Where the labor is severe or confining, maximum results may obviously be reached in fewer hours than where the work is light. It should be remembered that there is a limit for any particular class of work beyond which the worker will not be benefited. The hours should be short enough so that a man at the end of a day's work will not be exhausted, while on the other hand they should be of such length that he will be able to produce a volume of product, or "wealth," which will give him satisfactory returns for his efforts.

[1] Mr. Thompson rightly regards this latter point as exceedingly important.

These conclusions of Thompson's, though reached by him independently, undoubtedly reflect the views of Taylor, who in his letter to Miss Goldmark went on to say:

> I am a very firm believer in shorter hours, especially for women. There is one supreme fact, however, which always ought to be borne in mind by all philanthropists and managers, when they are advocating shorter hours, and better working conditions, etc., namely, that if they do not at the same time make provision for an increase in the ouptut of the individual per hour of work done, they in the long run are merely preparing their people for lower wages and harder conditions. This element of seeing that the productivity is increased in greater proportion than the hours are reduced, is time and again overlooked, whereas a careful study of the whole problem would make it possible in 99 cases out of 100 to very materially increase the output, at the same time that the hours are shortened.

We gather that Taylor's prescription for shorter hours was in general this: Concentrate. See that work and amusement are kept separate and distinct. Save labor with more machinery. Plan the work. Think it all out in advance. Intellectualize it in general. Certainly hours cannot be shortened without reducing income unless labor is saved. *And the only saver of labor is intellect.* Either the intellect that is projected into a machine, or the intellect that is used for the better handling of machines, the better care and issuing of tools, the better storage and issuing of materials, the better ordering of work, and so on and so forth.

The girl inspectors at the Simonds plant were scientifically selected on the basis of their possessing a low personal coefficient — that is, power of quick perception accompanied by quick responsive action. "Unfortunately," said Taylor, "this involved laying off many of the most intelligent, hardest working, and most trustworthy girls." Usually when investigation shows that a person is not adapted to the work he or she is doing, other work can be found for him or her in the same establishment as we presently shall see exemplified in the case of Taylor's systemizing work at Bethlehem. At the Simonds plant, however, there was no work save the inspection at which it was possible to employ women.

It was at this plant that Taylor had his first experience with women in industry. Just as he found that women in general are entitled to special consideration, so he found that in industry they require to be treated in a special way.[1] He was not enthusiastic over their being in industry. Not young women, anyway. Writing in 1914 to a member of the Yale Debating Association, he said:

> My extensive observations have made me come to the conclusion that younger women are not as regular in their attendance nor as efficient in work, relatively speaking, as men are.
>
> I think this is very natural, for the average young woman is not (and ought not to be) looking forward to a life spent in industrial work. She ought to be looking forward to getting married some day.

His statement of the "final outcome of all the changes" among the girl inspectors at the Simonds plant was that "thirty-five girls did the work formerly done by one hundred and twenty," while the "accuracy of the work at the higher speed was two-thirds greater than at the former slow speed."[2] He attributed these results not only to the scientific selection of the girls, to the over-inspection, to scientific time study, and to the payment of bonuses for quality as well as quantity, but also to what in effect amounted to functional foremanship. "Before they finally worked to the best advantage, it was found to be necessary to measure the output of each girl as often as once every hour, and to send a teacher to each individual who was found to be falling behind, to find out

[1] "All young women," he wrote in *The Principles* (p. 96), "should be given two consecutive days of rest (with pay) each month, to be taken whenever they may choose."

[2] *Ibid.*, p. 95.

what was wrong, to straighten her out, and to encourage and help her to catch up." Thus in summing up the "good that came to these girls" he said that in addition to averaging "from 80 to 100 per cent higher wages than they formerly received," and having their hours reduced, "each girl was made to feel that she was the object of especial care and interest on the part of the management."

Here again Taylor believed he proved that it is practicable, as he expressed it, to give working people "what they most want, namely *high wages*, and the employers what they most want, namely, the maximum output and best quality of work, — which means *a low labor cost*." He improved the quality of the product, not only by systemizing the work of the inspectors, but also by devising a new method of hardening bicycle balls to insure greater uniformity, and by making such improvements as that represented by a machine which automatically threw out balls that were "out of round" and so gauged the balls that they did not vary in size more than two ten-thousands of an inch. Simonds balls became the standard of quality, we are told, even in England.

Again a brilliant operating success, but again a financial disappointment. For this you hardly could blame anyone. Certainly not Taylor. As early as February, 1897, he wrote to the president of the company:

> Regarding the question of our ball sales, I think that it is most desirable that we should have a more careful system in this branch of our work. Of course you know I fully appreciate that I have nothing to do with this department of the work, but I still venture to make the suggestion. It seems to me that we ought to have a complete list of all ball purchasers in the United States. These ball purchasers should be tabulated so as to show the actual orders which they have given in the past and their probable present annual consumption. Such a list as this would enable us to take a broad view of the field and outline our policy intelligently.

Whether or not his suggestion of a careful study of the market [1] was immediately adopted, it eventually became manifest that the bicycle craze had led to the erection in various parts of the country of plants for the manufacture of bicycle balls representing a total capacity greatly in excess of the needs of the trade. Thus among these manufacturers there started a merry war for extermination. Balls that in April, 1897, sold at three dollars a thousand were selling in May, 1898, at seventy-five cents a thousand. Taylor wanted to go on. His sporting blood was aroused. If others in the field had more money than they, he was willing to pit his brains against their money. He was sure that the Simonds plant could manufacture the cheapest. He believed that when all their new machinery got working, they could meet the price of seventy-five cents and, far from losing money, make a "nice profit." And though, with this remaining to be demonstrated, he was unwilling to ask his relatives and friends to put more money into the company, he was willing to back up his judgment with more of his own money. But the principal owners of the business decided in the summer of 1898 to shut down, and eventually the business was liquidated. Taylor in a letter to one of the persons whom he had induced to invest money in the company called this "throwing up the sponge in a perfectly ridiculous manner." Yet, on the whole, he did not blame these men; for, as he remarked sadly, "they were financiers, not manufacturers."

However, in this summer of 1898, he had something else to think about besides the closing down of the Simonds works. As early as November of the previous year, he had received this letter from his old Midvale boss, Russell W. Davenport, who now had become second vice-president of the Bethlehem Steel Company:

[1] Technical men will observe that Taylor here anticipated one of the most important features of modern sales engineering.

My dear Taylor: —

I have been requested by our President, Mr. R. P. Linderman, to communicate with you in reference to the possibility of arranging to secure your services at an early date in connection with the proposed establishment of a piece work system in our Machine Shop.

I should like therefore to hear from you at your early convenience as to whether your present engagements will allow you to consider this question, and if so when you can make it convenient to come to Bethlehem and have a preliminary talk with Mr. Linderman.

END OF VOLUME I